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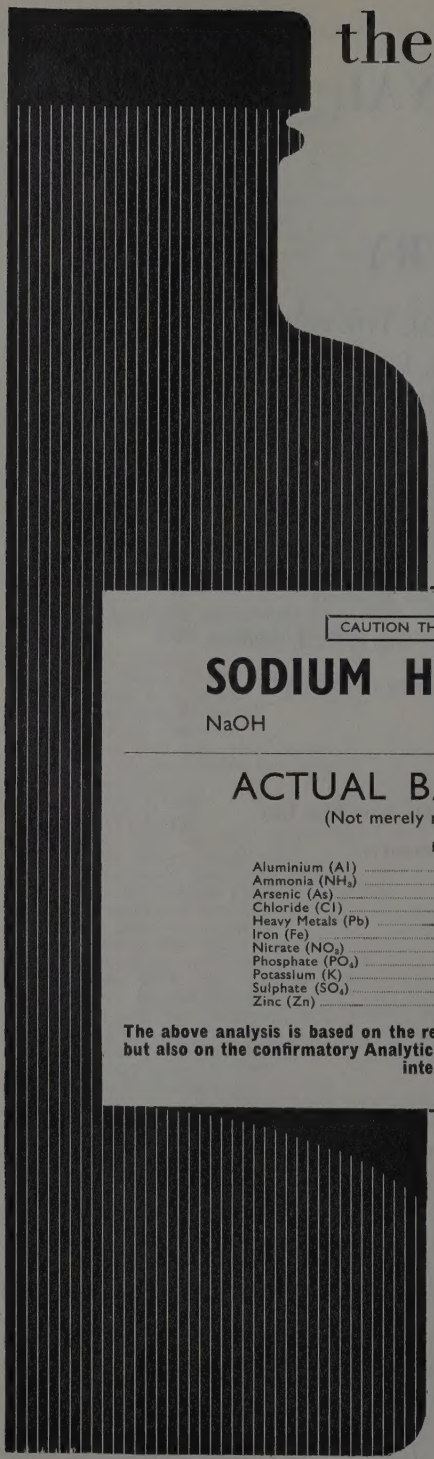

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FOR STUDENTS, PARENTS AND TEACHERS

GRANTS TO STUDENTS
THE ANDERSON REPORT

A Committee, under the chairmanship of Sir Colin Anderson, was appointed in June, 1958, 'to consider the present system of awards from public funds to students attending first-degree courses at universities and comparable courses at other institutions and to make recommendations.' After receiving evidence from a large number of associations and organizations, including the Institute, the Committee prepared their Report which was presented to Parliament in June (H.M.S.O., Cmnd No. 1051, 6*s*. 6*d*.).

Selection for Awards.—One of the main recommendations of the Committee is that all those ordinarily resident in Great Britain who are admitted to first-degree or comparable courses at universities and other institutions as full-time students should receive awards from public funds, provided they satisfy a minimum national qualifying standard such as the suggested two G.C.E. passes at 'A' level or the equivalent. This recommendation applies equally to men and women and without restriction as to age. In effect this means that selection by award-making bodies would be discontinued and that admission to a university or technical college would automatically give the student the right to an award.

State Scholarships.—The Committee recommends that all types of state scholarship (ordinary, technical, mature and supplemental) should be discontinued. All who would have won state scholarships under the present system will, under this recommendation, obtain a public award, and the Committee considers that nothing is gained from the university point of view by marking off a particular class of award-holders as state scholars. Furthermore, the Committee believes that ordinary state scholarships cannot maintain their attraction unless success in the competition carries with it a financial advantage, but in the Committee's view additional or 'bonus' payments from public funds to a particular class of award holder are not desirable.

It does recommend, however, that students should be allowed in future to retain £100 per year of any scholarship or grant from private funds or other personal income. The present policy of deducting from the public grant the whole value of the college or university award has had a deadening effect on many open scholarships, which have ceased to attract. This undesirable situation will be remedied if a 'bonus' of up to £100 is available to the student who wins such an award, even though pupils at certain independent schools may be in a more favourable position to obtain an award than those going to maintained grammar schools.

A note of dissent on this subject is recorded by one member of the Committee, Professor Brinley Thomas, who considers that state scholarships won on the G.C.E. examination are, for the majority of grammar schools not equipped to compete in the struggle for Oxford and Cambridge scholarships, a most important mark of success and prestige, and provide a valuable incentive. Professor Thomas believes that outstanding talent will be rewarded only if a boy or girl has competed for a university or college award, and the prestige attaching to scholarships at Oxford and Cambridge will become greater than ever.

Composition of Grants.—The present arrangement for distinguishing between fees and maintenance is endorsed by the Anderson Committee, and it considers that the method of expressing the maximum grant in terms of payment of fees plus a standard sum for maintenance should apply throughout Great Britain. Moreover, it recommends that each standard figure of maintenance should include the same amount for books, clothes and incidental expenses, and the amount for books in particular should be made public. The standard grants for maintenance should be available for vacations as well as during term-time.

The Parental Contribution.—Perhaps the most important recommendation of the Committee is that parental contributions should be abolished, and that parents of students receiving awards from public funds should not be eligible for income tax or surtax child allowances for those students. The minority view is that parental contributions in a modified form should be continued. Professor Brinley Thomas dissents from the majority and minority views by wishing to retain the parental contribution, on condition that at the same time substantial sixth-form bursaries are introduced in the maintained schools.

If parental contributions are retained it is suggested that no contribution should be required from a married couple with one child if their gross income is less than £1,000 (present minimum £700), and that the sliding scale of contributions thereafter should be based on 10 per cent of the balance of income, instead of 14 per cent as at present. This would mean, for example, that a married couple with one child would contribute, on average, about £50 if their gross income is £1,500 (present contribution £130), and about £100 if the gross income is £2,000 (£200 at present). It is also suggested that parental contributions should be waived for award holders who are aged 25 or over in the year in which the award is offered, and for award holders who have regularly and substantially supported themselves out of their earnings for three years before the year in which the award is offered. These modified

scales would have the effect of eliminating contributions from about 60 per cent of parents, and on the basis of 1958–59 figures would cost an additional £7·1 million. Complete abolition of parental contributions on the same basis would cost an additional £8·2 million.

Administration of Grants.—At present the responsibility for assisting students is undertaken by 181 Local Education Authorities and two government departments, the latter being responsible for the state scholarships. Whatever the nature of the bodies dealing in future with the actual making of the awards, the Committee recommends that the policy to be followed by them should be settled nationally. The Committee rejected suggestions that grants should be administered by the universities or by an *ad hoc* national grants board, but put forward three possibilities for the future administration of awards: (i) entirely by the Ministry of Education and the Scottish Education Department; or (ii) by the two Departments, but with local authorities acting as their agents in performing some functions which can best be carried out locally; or (iii) by the local authorities, under rules drawn up by the two Ministers, subject to the students having a right of appeal to one or other of the Ministers.

UNIVERSITIES' ADMISSION PROCEDURE

Nearly two years ago (January, 1958) the committee of Vice-Chancellors and Principals of the Universities of the United Kingdom set up an *ad hoc* committee to study the procedures for admission of students to universities. Their first Report was issued in May, 1958, but after a full year's experience of the revised procedures the *ad hoc* committee has published a second report in which the situation is reviewed in the light of returns to a questionnaire sent to all universities, except Oxford and Cambridge, in October, 1959.

In this questionnaire every institution was asked to state the number of applications received for admission in October, 1959, to full-time first-degree courses. The returns, not including Oxford and Cambridge colleges, showed that about 134,000 applications were lodged for the 1959–60 session, 40,700 in science and 21,700 in technology. Altogether about 20,300 students were actually admitted to first-degree courses, 5,810 in science and 3,240 in technology.

The ratio of the number of applications to the number of places available varied considerably from one university to another and from one faculty to another. The average for English universities was 7·85 applications per place, for Wales 4·6 and for Scotland 2·45.

The *ad hoc* committee, in its first report, made a number of definite recommendations (*J.*, 1958, 568). These have been adopted by university institutions and, with only a few exceptions, applied to applications for entry in 1959. The second report examines the working of these proposals in 1959, and makes further recommendations for their extension. It is apparent that the modification of application forms, the standardization of report forms for heads of schools and the adoption of standard letters making offers of places to students have already resulted in a considerable improvement in the procedure for admission to universities. The report comments on several problems connected with university admission procedure that continue to cause concern and, in particular, expresses the hope that small-scale experiments with 'clearing-up houses' for specific subjects will be tried before a more ambitious programme for such a system is launched.

The report contains a useful appendix on 'getting into a university,' which is intended as a guide for sixth formers. Copies of the report may be obtained from the Secretary, The Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, price 2*s*.

THE CROWTHER REPORT

Volume II of The Crowther Report (*15 to 18*, H.M.S.O., 8*s*. 6*d*. net) has recently been issued. It sets out the results of three surveys carried out between 1956 and 1958 dealing with the adolescent and young worker. Particulars were obtained of nearly 30,000 young people, mostly men, all of whom had left school. In two of the three surveys the information was obtained by personal interview. The Central Advisory Council for Education (England), under the chairmanship of Sir Geoffrey Crowther, needed to find out the extent of latent ability among young people, the social composition of the schools, the influences favourable or hostile to prolonged school attendance, and the effective use made of facilities for further education and leisure.

The Social Survey, described in Part One, was carried out in 1957 and is concerned with more than 3,000 young men and women, selected at random, who had left grammar, technical or modern schools one and a half to three years earlier. This survey was undertaken by the Government Social Survey, Central Office of Information. The results of the survey suggest how far attendance at grammar and technical schools beyond the compulsory period is associated with various types of home background.

Part Two describes a survey conducted in 1957–58 of some 9,000 national servicemen and covers much the same ground, with rather similar results, as the Social Survey. Unlike the latter, however, it makes an objective measure of the ability of the recruit based on five objective tests given to each recruit on entry.

The Technical Courses Survey held in 1956 and 1958, and forming Part Three of the Report, establishes broad facts about the efficiency of the part-time process of further education in relation to the National Certificate and certain City and Guilds courses.

THEORY OF THE METALLIC STATE

By J. A. CATTERALL, PH.D.

National Physical Laboratory, Teddington

In attempting to distinguish between metals and non-metals, a comparison of various physical properties leads to the conclusion that the most distinctive feature of a metal is its ability to conduct electricity with an electrical resistance which increases with temperature. Consequently any theory of metals must explain satisfactorily the mechanism by which the electrons in a metal carry the current, and it was this aspect of the subject which occupied the attention of the early workers in the field.

HISTORICAL BACKGROUND

In 1853 Wiedemann and Franz discovered an empirical law which states that the ratio of the electrical and thermal conductivities at a given temperature is the same for all metals, and a theoretical derivation of this law was first given by Drude in 1900. Drude realized that the electrical properties of a metal must be ascribed to the presence of relatively 'free' electrons which would be fairly easily transported through the metal by an applied electric field. Such a 'gas' of electrons would tend to diffuse under a thermal gradient, which would also account for the thermal conductivity of the metal. In the absence of an electric field or a thermal gradient the electrons were assumed to have a uniform velocity v and to pursue random motions through the metal due to collisions with the metal ions. Owing to their large mass the ions were considered to be immovable. The application of an electric field accelerates each electron in the direction of the field until it collides with an ion, and the electrical conductivity σ is given by

$$\sigma = ne^2l/mv$$

where n is the number of 'free' electrons per unit volume, e is the charge and m the mass of the electron, and l is the 'mean free path' (*i.e.* the velocity multiplied by the average time between collisons).

Drude's model gives for the thermal conductivity, K, the expression

$$K = \frac{2}{3} lvC_v$$

where C_v is the specific heat of the free electrons per unit volume at constant volume.

If the electrons are assumed to behave like a classical ideal gas, then $C_v = 3k/2$, where k is Boltzmann's constant, and $mv^2 = 3kT$. Consequently the Wiedemann–Franz ratio, K/σ, becomes $K/\sigma = 3(k/e)^2T$, and the Wiedemann–Franz law follows. This expression also verifies the rule formulated in 1872 by Lorenz that the Wiedemann–Franz ratio is proportional to the absolute temperature. In addition, the value of the Lorenz number, defined as $K/\sigma T$, is in reasonable agreement with the values actually found for metals at room temperature. However, a serious objection to Drude's theory was that the temperature-variation of the electrical conductivity could not be reconciled with the expression for σ given above.

Drude had assumed a uniform velocity for the electrons, whereas in 1904 Lorentz assumed that the electron velocities in a metal at constant temperature were distributed according to classical Maxwell–Boltzmann statistics. Lorentz also made appropriate modifications to the distribution when electric fields and temperature gradients were present, and arrived at more precise expressions for the electrical and thermal conductivities. In spite of the more refined calculations of Lorentz, two very serious objections to the theory became apparent. The first was that the application of Maxwell–Boltzmann statistics implied that the electrons made a considerable contribution to the total specific heat of the metal, whereas in 1912 Debye showed that the specific heats of solids could be satisfactorily accounted for by considering only the thermal vibrations of the ions constituting the lattice. The second was that it also failed to predict the correct temperature-variation of the resistance.

Relatively little progress was made in the theory of metals until Pauli put forward the exclusion principle in 1925 that no two electrons could have the same four quantum numbers. This principle was incorporated into a new form of quantum statistics by Fermi and Dirac, and the Fermi–Dirac statistics were applied to the electron gas in a metal by Sommerfeld in 1928.

FERMI–DIRAC DISTRIBUTION

In an assembly of electrons moving independently, the average occupation number of a quantum state with

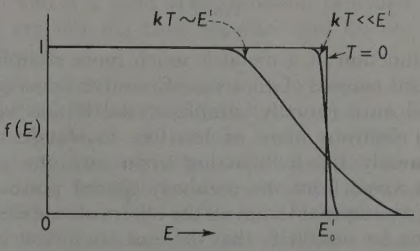

FIG. 1

energy E is $f(E)$, where $f(E)$ is the Fermi–Dirac distribution function defined by

$$f(E) = [\exp\{(E - E')/kT\} + 1]^{-1}$$

and E' is a parameter determined by the total number of

electrons present. Since each quantum state can contain two electrons of opposite spin the average occupation of a quantum state is $2f(E)$. The form of $f(E)$ as a function of E for various relations between T and E' is shown in Fig. 1. The most important point here is that at absolute zero $f(E)$ is unity when $E_0' > E$, and zero when $E > E_0'$. This means that all energy levels below E_0' are filled, each level containing two electrons, whereas all levels above E_0' are empty. The significance of this will be considered below.

SOMMERFELD'S MODEL

It will be recalled that, according to the wave-mechanical treatment, the energies which the valency electron of the hydrogen atom can possess are determined by the solutions of the Schrödinger equation

$$\nabla^2\psi + \frac{2m}{\hbar^2}[E - V(r)]\psi = 0$$

where E is the total energy of the electron, $\hbar$ is equal to $h/2\pi$ where h is Planck's constant, and $V(r)$ is the potential energy of the electron at a distance r from the nucleus. It is only possible to obtain acceptable solutions for the function ψ for certain definite values of E, which correspond to the successive stationary states of the Bohr theory of the hydrogen atom. The physical significance of the wave function ψ is that $[\psi(r)]^2 dv$ is equal to the probability that the valence electron is in the volume element dv at the point r.

In the problem of the hydrogen atom the potential $V(r)$ is simply equal to $-e^2/r$, the potential energy of the electron at a distance r from the nucleus. The potential

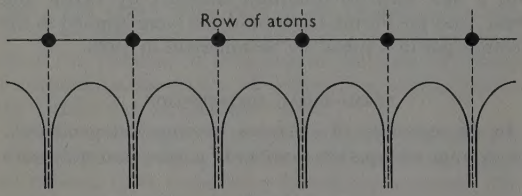

FIG. 2

energy function in a metal is much more complicated. The metal consists of an array of positive ions regularly arranged on a (usually) simple crystal lattice with the valence electrons more or less free to wander about. Consequently the field acting upon any one valence electron arises from the regularly spaced positive ions plus the average field from all the other valence electrons. Assuming for simplicity that the ions are at rest in their lattice positions, the potential $V(r)$ is clearly periodic with the period of the crystal. If a line were drawn passing through the nuclei of atoms which are nearest neighbours in the crystal and $V(r)$ were plotted against distance along this line, the curve would resemble that shown in Fig. 2. The potential energy of the electron is lowest near an ion and rises to a maximum midway between two ions.

In order to simplify the calculation, Sommerfeld considered the field inside a metal to be uniform and $V(r)$ to be constant. The potential of the field in which an electron moves, plotted along a line through the metal, will then appear as in Fig. 3, the potential being constant within the metal but rising sharply to a value w at the surface. This model is not as crude as might be supposed, and, for reasons which will be given later, gives good agreement with the physical properties of some

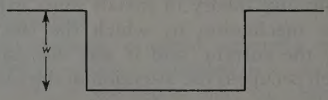

FIG. 3

of the alkali metals. Each valency electron is characterized by a wave function ψ which is a solution of Schrödinger's equation for a particle moving in a constant potential field.

Considering Schrödinger's equation in one dimension, the wave functions are solutions of

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}E\psi = 0$$

and the solutions of this equation which satisfy the boundary condition that ψ must vanish at the surface of the metal (since the electron remains within the metal) are

$$\psi = (2/l)^{\frac{1}{2}} \sin(\pi n x/l)$$

where $n = 1, 2, 3 \ldots$ and l is the length of the one-dimensional metal.

The corresponding energy levels are given by

$$\frac{2m}{\hbar^2} \cdot E_n = \frac{\pi^2 n^2}{l^2}$$

Since for any piece of metal l is much larger than any of the other quantities in this expression, the separation between the levels E_n is very small indeed, so that the energy levels may be regarded as forming a continuum.

It has been shown above that the Fermi–Dirac distribution function for $T = 0$ indicates that each energy level for $E > E_0'$ is empty. In most metals the value of E_0' is several electron volts, and it is usually denoted by E_{max} or the 'maximum Fermi energy.'

The way in which the electron energy states are distributed with energy is shown by the graph of $N(E)$ against E, $N(E)$ being the number of states per unit energy range. For the Sommerfeld model it may easily be shown that

$$N(E) \propto E^{1/2}$$

The curve is known as the 'density of states,' and it is shown in Fig. 4. The shaded area represents occupied energy levels, and since each level contains two electrons

it is proportional to the number of electrons per unit volume of metal.

Sommerfeld's so called 'free-electron' model removed the previous difficulty regarding the specific heats. It is clear from Fig. 4 that only electrons at the top of

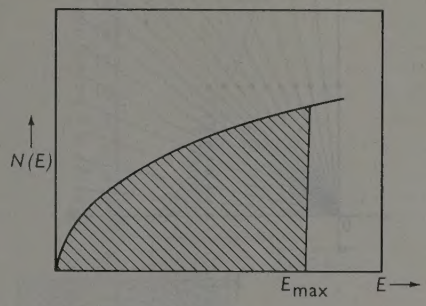

FIG. 4

the energy distribution can absorb energy and be promoted into higher levels, since it is only these electrons which have vacant levels above them. Consequently the amount of energy absorbed by the electrons is only a negligible proportion of the total specific heat at ordinary temperatures, and Debye's results become understandable. The value of the Lorenz number obtained by Sommerfeld was also in good agreement with experiment.

Sommerfeld's model shows that as the free atoms condense to form the solid metal, the sharp energy levels of the valency electron in the free atom broaden into a band of closely-spaced levels associated with the crystal as a whole, the band having an energy-breadth of several electron-volts. However, this picture would be true for all solids, and the model does not show why metals conduct electricity and insulators do not. The reason is that Sommerfeld neglected the periodic nature of the potential field in his calculations.

THE ZONE THEORY OF METALS

The wave functions which are solutions of Schrödinger's equation for a *constant* potential were shown above to be of the type

$$\sin(\pi n x/l)$$

This may be re-written as the sum of two 'running waves' moving in opposite directions

$$Ae^{ikx} + Be^{-ikx}$$

where the 'wave number' $k = \dfrac{2\pi n}{l} = \dfrac{2\pi}{\lambda}$

and where λ is the wavelength of the function. The relation between the allowed energies E and the wave number k is given by

$$E = \frac{\hbar^2}{8\pi^2 m}.k^2$$

and it is shown in Fig. 5.

The wave functions and energy levels which are solutions of Schrödinger's equation for a *periodic* potential are quite different. In this case the wave functions take the form

$$e^{ikx}.\psi_k(x)$$

where $\psi_k(x)$ is periodic with the period of the lattice. A number of different approximations have been made by various workers in order to simplify the mathematical problems. Among these are the following:

(*a*) *The approximation of 'nearly free electrons.'* This method assumes that the periodic potential is only slightly different from the constant potential assumed by Sommerfeld, and that the wave functions are combinations of the type e^{ikx}. The advantage of this approach is that it can be handled by the standard perturbation methods of quantum mechanics. It was one of the earliest ways of dealing with the problem but in actual fact it forms a poor approximation to the situation in a metal because the effect of the periodic potential is much too great to treat as a perturbation.

(*b*) *The Bloch or 'tight-binding' approximation.* Here the wave functions are made up of linear combinations of functions of the type $e^{ikx}.\psi_k(x)$, where the $\psi_k(x)$ are atomic functions. This method takes into account the

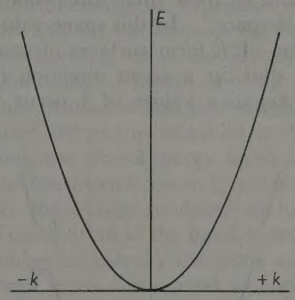

FIG. 5

variation of the potential near to an atomic site in the crystal and is a good approximation provided that the atoms are not too close together and do not interact too strongly.

(*c*) *The Cellular method.* This method was first proposed by Wigner and Seitz[1] who used it to calculate the energy band in metallic sodium. The metal is divided up into polyhedral cells, each cell surrounding one atom. Schrödinger's equation is then solved for this cell for a variety of internuclear distances, subject to the condition that the wave functions must join up smoothly from one cell to the next. In the case of sodium the potential in the cell was considered to be near to that of the Na^+ ion. The cellular method has in the past given results which were of great qualitative value, but owing to the considerable mathematical labour involved the boundary conditions were applied

only to the centres of the faces of the polyhedra. More recent workers have solved the equations for many more points on the cells, notably Von der Lage and Bethe[2] and Howarth and Jones,[3] and this work is believed to be among the most accurate of any of the various methods.

(*d*) *Recent methods.* Two developments known as the 'orthogonalized plane wave' and the 'augmented plane wave' methods have somewhat different starting wave functions from those described above in order to improve the accuracy of the calculations. The orthogonalized plane wave method has been used with success for beryllium.[4]

The results of all the above types of calculation, which take into account the periodic nature of the crystal field, show that only certain values of the energy of the electron states in the crystal are allowed. This is in contrast to the model of Sommerfeld where all values of E were possible, and where the curve of energy against wave number was continuous (Fig. 5).

The wave function in three dimensions

$$e^{\pm ikr}\,\psi_k(r)$$

may be regarded as a wave travelling in the direction of k with a wavelength λ, where $\lambda = 2\pi/k$. The values of k may be represented by three components at right angles k_x, k_y and k_z, these three dimensions constituting the so-called 'k-space.' In this space values of k having the same value of E form surfaces of constant energy. Fig. 5 shows that for a given direction in the crystal positive and negative values of k occur for the same

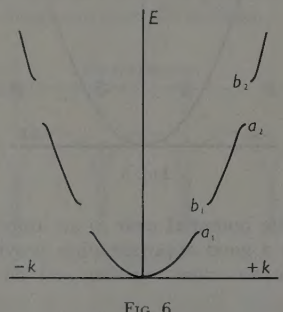

FIG. 6

energy. It has been shown above that in the valence band the electrons have energies ranging from zero up to a value E_{max}, and for Sommerfeld's model the surface E_{max} is the surface of a sphere in k-space. The volume of the sphere is proportional to the number of occupied energy states, and the surface formed by the highest occupied states is called the 'Fermi surface.'

When the periodic nature of the crystal field is taken into account, the curve of energy against wave number for any one direction in the crystal becomes modified to the form shown in Fig. 6, and the values of the energy between a_1 and b_1, a_2 and b_2, etc., are forbidden. The position and magnitude of the gaps a, b, etc. depend on the solid and on the direction considered. Fig. 7 shows

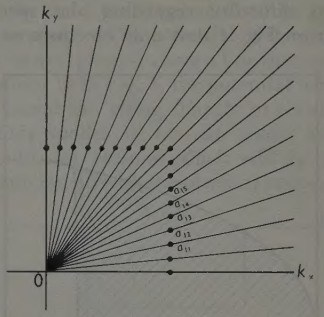

FIG. 7

in two dimensions the points at which the first energy discontinuity occurs for directions between k_x and k_y in a simple square lattice of atoms. These points trace

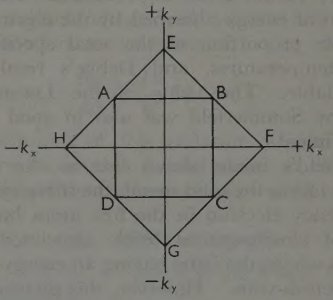

FIG. 8

the outline of a square, the square ABCD shown in Fig. 8. The points of the *second* energy discontinuity (a_2b_2 of Fig. 6) trace the square EFGH in Fig. 8. In *three* dimensions these points build up polyhedra in k space known as Brillouin Zones, the points a_1b_1 (Fig. 6) forming the First Brillouin Zone, a_2b_2 the Second Brillouin Zone, and so on. The shapes of the polyhedra

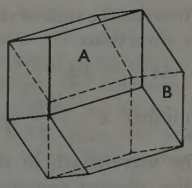

FIG. 9

depend upon the crystal structure of the metal, and the First Brillouin Zone of the body-centred cubic lattice is shown in Fig. 9.

The introduction of these planes of energy discontinuity (the faces of the zones) modifies the energy contours in k-space. In Fig. 10 the central square represents the

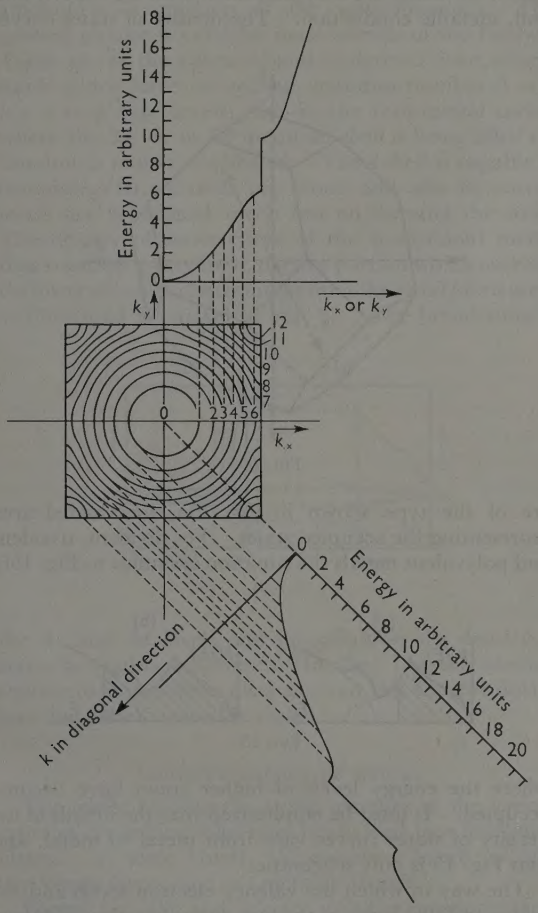

FIG. 10

First Brillouin Zone of the two-dimensional square lattice. At low energies the periodicity of the crystal field has little effect, and the energy contours are circles as in the free electron model in two dimensions. As the energy approaches that of the boundary of the zone the circles become deformed, and the energy against wave-number curve becomes modified. The type of modification for two directions in the lattice is illustrated in this figure.

Starting from the energy origin in Fig. 11a, the density of states curve rises smoothly and parabolically as in the free-electron model until the energy contours in k-space reach the nearest zone face. Above this energy the number of energy states available decreases because of the approach of the contours to the corners of the zone, and the density of states curve ultimately falls to zero. There is then an energy gap across the zone faces to the lowest energy in the second zone, above which the density of states curve rises again. In many cases, however, the highest energy in the first zone is higher than the lowest energy in the second, in which case the density of states curves for the two zones overlap, as shown in Fig. 11b.

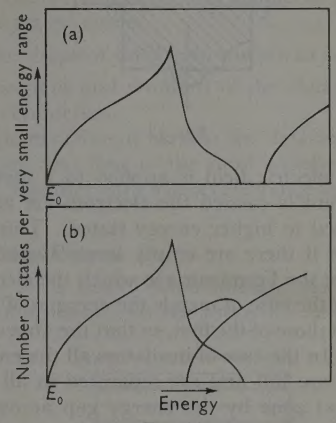

FIG. 11

The variation of energy as a function of k within the Brillouin Zones and the variation of the density of states curve $N(E)$ with energy is of considerable importance for the understanding of metals, and for distinguishing between metals, insulators and semi-conductors.

To summarize, the picture of a solid on the band model is one in which the sharp energy levels of the valency electrons of the free atom become broadened into a band of energies as the atoms condense to form the solid, the degree of occupation of the band of levels depending upon the number of valency electrons available. The occupied energy levels correspond to a certain volume in k-space, and in the case of the 'free electron' model, or for low energies in the first zone, this volume is the volume of a sphere. The energy contour of the highest occupied states in k-space forms a surface known as the 'Fermi surface,' and near to the zone boundaries becomes distorted from its spherical form. If the valency electrons are visualized as gradually being added to the initially empty structure, the Fermi surface will expand from the origin of k-space, retaining its spherical form until it approaches the zone boundary. If sufficient electrons are available the occupied states may completely fill the first zone, leaving an energy gap *in all directions* between the highest occupied state and the lowest empty state in the second zone. Alternatively the electrons may start filling up the second zone before the first zone is full, if the energy of the lowest state in the second zone is lower than the highest state in the first. The latter is the situation in metals, and in two dimensions the process may be represented as in Fig. 12. Here the shaded area corresponds to occupied states in

k-space, with the Fermi surface now being partly in the second zone and partly in the first.

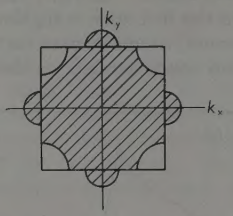

FIG. 12

When an electric field is applied to a metal and an electric current is carried the electrons are accelerated, and are raised to higher energy states. This process is only possible if there are empty levels available immediately above the Fermi surface which the electrons may occupy. In the case of metals the energies of the second zone overlap those of the first, so that the above condition is fulfilled. In the case of insulators all the energy states in one zone are full and are separated in all directions from the next zone by the energy gap across the zone faces. The energy gap is too large for the electrons to cross, so that the electric field produces no net effect on the electronic motion and consequently no current. Semi-conductors represent a situation intermediate between metals and insulators, and here one zone is full but the energy gap across the zone faces is very small. At low temperatures the substance behaves as an insulator, but at higher temperatures electrons become thermally excited across the energy gap into the next zone where they are able to produce metallic conduction. Semi-conductors may be distinguished from metals in that as the temperature rises and more electrons are excited into the second zone their resistance decreases.

It is characteristic of metals that they solidify to form relatively simple crystal structures, and two of the most

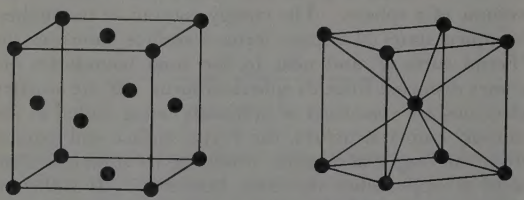

FIG. 13

common are the body-centred cubic (bcc) and face-centred cubic (fcc) types (Fig. 13). For example the alkali metals Li, Na, K, Rb and Cs have the former, and the noble metals Cu, Ag and Au the latter structures. The first Brillouin Zone for the bcc lattice was shown in Fig. 9, and the first Zone for the fcc lattice is shown in Fig. 14. It may easily be demonstrated that both these zones have all their electron states occupied if there are two valency electrons per atom available in the crystal. Since both the alkali and the noble metals are monovalent the zones are only half filled, and we expect, and find, metallic conduction. The density of states curves

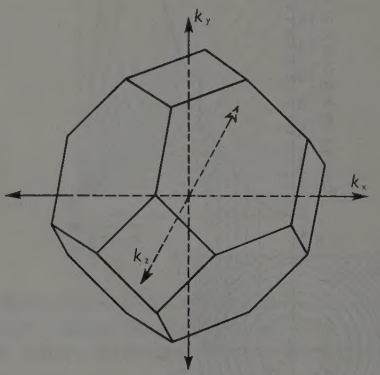

FIG. 14

are of the type shown in Fig. 15a, the shaded area representing the occupied states. For divalent, trivalent and polyvalent metals the situation is similar to Fig. 15b,

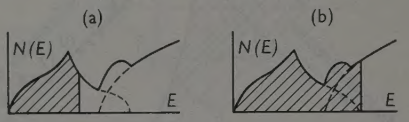

FIG. 15

where the energy levels of higher zones have become occupied. It must be emphasized that the details of the density of states curves vary from metal to metal, and that Fig. 15 is only schematic.

The way in which the valency electron levels and the higher unfilled levels of the free atoms broaden in energy as the interatomic distance decreases is illustrated in Fig.

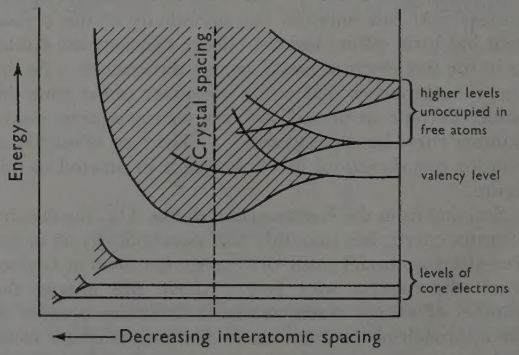

FIG. 16

16. At the interatomic distances normally encountered in metals, the inner wave functions of the ions interact only by a negligible amount and the energy levels remain sharp. The amount of broadening is a measure of the amount of interaction of the wave-functions. This general picture is valid for many metals of the Periodic Table where the valence band is derived from atomic levels which have the second quantum number 0 or 1 (*i.e.* *s* or *p* type levels), but in the transitional metals where the 3*d*, 4*d* or 5*d* quantum shell is being filled the situation is more complicated. The *d* shell is capable of containing 10 electrons per atom, and also its energy levels are broadened much less on forming the solid. The density of states curve of the transitional metals thus contains a very high, narrow portion which overlaps the lower, broader contribution from the *s* and *p* functions, as illustrated for nickel in Fig. 17. The broadening of

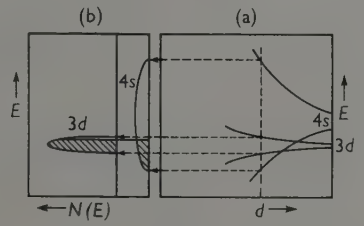

FIG. 17

the 4*s* and 3*d* levels and the effect on the density of states is readily apparent. In Fig. 17a the abscissa represents interatomic distance, and the vertical dotted line the value in metallic nickel.

COHESIVE FORCES IN METALS

The forces holding the atoms together in the various types of crystalline solid may be divided into four main classes: (*a*) ionic bonds; (*b*) co-valent bonds; (*c*) van der Waals forces, and (*d*) metallic 'bonds.'

Forces (*a*), (*b*) and (*c*) are familiar to students of chemistry, but force (*d*) is not so readily visualized since at first sight there appears to be no reason why, for example, an array of copper atoms should attract each other sufficiently to form solid copper. The reason is that the broadening of the valence band which occurs during the formation of the solid has the effect of lowering the average energy of the valence electrons, but a discussion of this is outside the scope of this article. The amount by which the average energy is lowered corresponds to the cohesive energy.

The energy band picture described above is undoubtedly qualitatively correct, but owing to the difficulties of the calculations and the approximations which it is necessary to make, the quantitative details must be arrived at by an appeal to experiment, and a few of the experiments which have been used to determine the present models will be discussed briefly below.

EXPERIMENTAL METHODS

The experimentalist attempts to establish one or more of the following points:

(i) The energy range of the outermost electrons, *i.e.* the width of the valence band from $E = 0$ to $E = E_{max}$.

(ii) The form of the distribution of the energy states over this energy range, *i.e.* the shape of the $N(E)$ or 'density of states' curve.

(iii) The shape of the Fermi surface in *k*-space.

(iv) The signs and numbers of the charge carriers in electrical conduction.

No single experiment permits the determination of all these factors, but four of the most widely used will be described, together with a short reference to more recent work.

(*a*) *Soft X-ray Emission Spectra*

In Fig. 18 is shown schematically the energy level diagram of a metal. At the top is the broad band AB

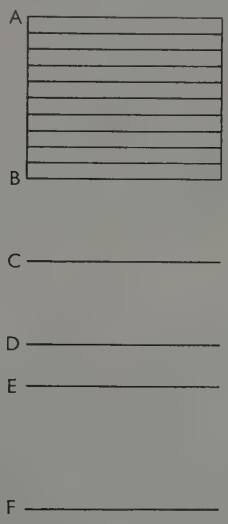

FIG. 18

of closely-spaced levels occupied by the valence electrons, and beneath, the narrow levels CDE etc. of the ions of the lattice. If an electron from the level C immediately below the energy band is removed, the vacancy which it leaves will immediately be filled by an electron falling down from the valence band. The energy which is released by this electron appears as X-radiation of long (*i.e.* 'soft') wavelength, in the region 100–300Å. Subject to certain restrictions, all the electrons in the band take part in this process, so the radiation emitted accordingly occupies a wavelength band. The width of the wavelength band equals the width of the valence band, and the shape of the intensity versus wavelength curve is a measure of the shape of the density of states curve.

The method of exciting the soft X-rays is to bombard a specimen target with electrons as in the conventional X-ray tube, but at much lower voltages. The emitted radiation is analysed by a diffraction grating and the intensity measured with a photographic plate or a counter. The whole experiment is carried out in a vacuum because of the absorption of air for radiation of this wavelength.

The results of soft X-ray emission experiments give energy band widths of the right order of magnitude, *i.e.* several electron volts, and in the case of lithium, sodium and potassium the band width is quite near to that expected on the 'free electron' model.

	Li	Na	K
E (observed)	4.5	3.0	1.9
E ('free electron')	4.7	3.2	2.1

The units of energy are electron volts

The shape of the curve is a measure of the 'density of states curve,' and the L emission spectrum of aluminium (Fig. 19*b*) is compared with the calculated density of states curve in Fig. 19*a*.

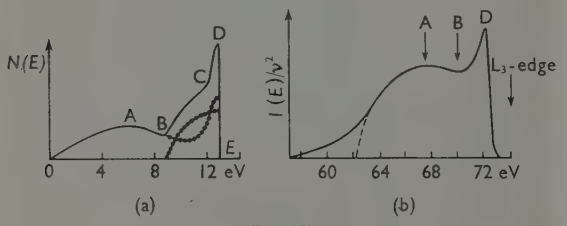

FIG. 19

(*b*) *Electronic Specific Heat*

The total specific heat of a metal is, in general, partly due to the lattice vibrations and partly to the energy band. The specific heat may be written as

$$C_v = C(\text{electronic}) + C(\text{lattice})$$

and the lattice specific heat has been shown to be of the form

$$C(\text{lattice}) = \alpha T^3, \text{ where } \alpha \text{ is a constant.}$$

The contribution from the electrons comes from the top of the energy band and is much less than the lattice term at ordinary temperatures. The band theory shows that

$$C(\text{electronic}) = \gamma T$$

where γ is a constant and is equal to

$$\gamma = \frac{2}{3}.\pi^2 \boldsymbol{k}^2.N(E)$$

where $N(E)$ is the density of states at the Fermi surface, and $\boldsymbol{k}$ is Boltzmann's constant.

Since $C_v = \alpha T^3 + \gamma T$ it is only at very low temperatures that the term γT becomes an appreciable proportion of the total, and consequently liquid helium temperatures are required for accurate determinations of γ. In the experiments the specific heat is determined for various temperatures and C_v/T is plotted against T^2. The value of the intercept obtained by extrapolation to $T = 0$ is equal to γ.

The constant γ is proportional to the density of states at the Fermi surface of the metal. In metals where the Fermi surface has overlapped one or more Brillouin Zone faces, the density of states curve shows maxima and minima, and in general the value of γ will be very different from that expected on the free electron model. The overlapping occurs in the polyvalent metals, and the figures shown below are the ratios of the observed γ values to those calculated for free electrons.

	Be	Mg	Ca	Sn	Ba	Zn	Cd
γ(obs.)/γ(free)	0.47	1.33	1.82	2.01	1.44	0.86	0.73

It is interesting to note that the ratios for the alkali metals sodium and potassium are 1.22 and 1.03 respectively, suggesting that these are very nearly 'ideal' metals.

In the transitional metals where the density of states is modified by the high, narrow contribution from the *d* electron levels, large γ values are found when the top of the filled region falls within this part of the curve. It has been found both experimentally and theoretically that the contribution to the density of states made by the *d* levels has a double-peaked structure. In passing along any one long period it may be assumed as a rough approximation that the density of states curve for all the metals is the same, the metals differing only in the extent to which the band is occupied. In the first long period the 3*d* band of electrons is progressively filled between scandium and nickel, and a theoretical form of

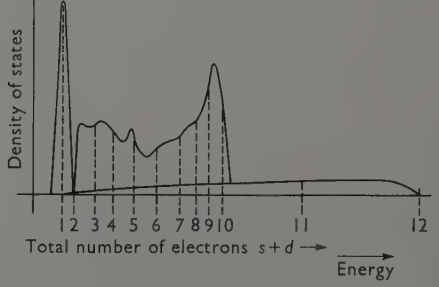

FIG. 20

the $N(E)$ curve is shown in Fig. 20. The total number of electrons ($4s + 3d$) varies from three (scandium) to ten (nickel), the dotted lines representing the height to which the band is filled. The values of γ consequently show the double-peaked curve when plotted against atomic number, as in Fig. 21.

(c) The Magnetic Susceptibility

The magnetic properties divide metals into three classes: diamagnetic, paramagnetic and ferromagnetic. The intensity of magnetization, I, in a magnetizing field of strength H is a characteristic property of a metal and the susceptibility is defined as I/H. It may be shown that in simple metals the paramagnetic susceptibility due to the electrons in the valence band is given by:

$$\chi = 2(\mu_0)^2.N(E)$$

where μ_0 is the unit of magnetization known as the 'Bohr magneton.' Consequently, provided a correction is made for the diamagnetism of the lattice ions, we may obtain $N(E)$, the density of states at the Fermi surface, by this method.

The most usual method of determining susceptibility is to use the fact that a metal specimen situated in a magnetic field gradient has a force exerted upon it which is proportional to (among other terms) the susceptibility. This force is measured by attaching the specimen to a balance.

The values of χ are small for the non-transitional metals, but in the transition metals where $N(E)$ is large the values of χ are also large and follow the same general trend as the γ values (Fig. 21).

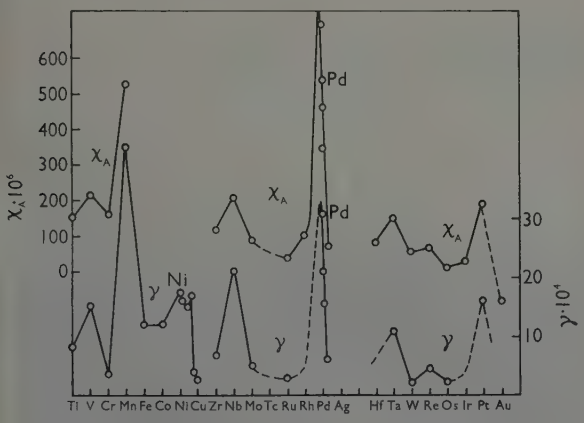

FIG. 21

(d) The Electrical Properties

There are several types of electrical measurement which are very useful in assisting the theory of the electronic structure of metals but, however, only give qualitative results owing to the difficulties of interpretation. Among these are the resistivity, the Hall coefficient, the thermoelectric power and the magneto-resistance. In different ways all these measurements give an indication of the properties of the electrons at the Fermi surface since it is only these electrons which are responsible for carrying the current. Some indication may also be obtained of the geometry of the Fermi surface, but space prevents a more detailed discussion of these measurements here. An examination of the results shows that sodium and potassium are nearly 'free electron' metals but that all the others differ in varying degrees from this model.

THE ELECTRONIC STRUCTURE OF ALLOYS

The mathematical difficulties of calculating the electronic structure of a solid alloy, in which the solute atoms are arranged in a random fashion on the lattice points of the solvent, are very considerable, and a combination of theory and experiment is required in order to arrive at a satisfactory model. The earliest and one of the most successful applications of the band theory of metals to alloys, by Jones[5], was in interpreting the extent of the primary solid solution range in copper- and silver-rich alloys. In this model the addition of a solute of higher valency is assumed to have no effect on the band structure of the solvent except to raise the Fermi energy and increase the height to which the band is filled. This model at once offers a method of exploring the density of states curve of the solvent metal, since by alloying with a metal of higher or lower valency the Fermi energy will be raised or lowered and the density of states at the Fermi surface changed. Measurements of the electronic specific heat or magnetic susceptibility on such alloys permit the density of states curve to be determined.

This model appears to work in many cases, especially where the atomic number of the constituents differs only by one, and for very dilute solutions. However, where the solute and solvent differ appreciably in atomic number it appears more probable[6] that only one of the solute valency electrons is contributed to the energy band, the rest remaining in 'bound states' around the highly charged solute ion and screening it from the solvent. In some cases it is possible to decide on the electronic state of the solute ion by measuring the magnetic susceptibility and the soft X-ray emission spectra from the alloy.

When a transitional metal is alloyed with a non-transitional metal the situation is more complicated, since the d levels contributed by the transitional metal atom cannot be expected to form part of a common energy band with a solvent metal which does not have such levels, especially if the elements are well separated in the Periodic Table. Friedel[7] has examined the electrical resistivity of the transitional elements of the First Long Period dissolved in either copper or aluminium, and the results are consistent with a model in which the d electrons tend to stay in localized positions around the solute transitional atom.

RECENT WORK

Two types of experiment performed recently allow the geometry of the Fermi surface to be determined. These are the 'Anomalous Skin Effect' and the De Haas–Van Alphen effect. In the Anomalous Skin Effect the surface resistance to a high-frequency current

is determined at low temperatures, whilst in the De Haas–Van Alphen effect the variation of the magnetic susceptibility with the magnetizing field is measured. By determining these properties as a function of the orientation of single crystals of the material it is possible to map out the geometry of the Fermi surface.

By the Anomalous Skin Effect, Pippard[8] has determined the Fermi surface in copper and finds it to be nearly spherical except near the (111) faces of the Brillouin Zone where the Fermi surface touches them. Cohen and Heine[9] have proposed an alloy model in which the band structure is modified by the solute atom, in order to reconcile Pippard's measurements with the Jones model of copper-base alloys.

Progress in the theory of metals and alloys is at present being made by the semi-empirical experimental approach in order to bring out any general trends in the physical properties which might help the theoretician. The errors of earlier methods are now becoming apparent, and as newer methods and more computing facilities become available the theory should eventually be established on a much sounder basis than it is at present.

The work described above has been carried out as part of the General Research Programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

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Suggestions for Further Reading

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CHEMISTRY IN THE UNIVERSITY OF SYDNEY

During the afternoon of Tuesday, 28 June, the New Chemistry School in the University of Sydney was officially visited by the Premier of New South Wales, The Rt Hon. R. J. Heffron, accompanied by the Chancellor of the University, Sir Charles Bickerton Blackburn, together with the University Senate, benefactors, and representatives of firms which have assisted by donations, gifts of equipment and so on. These, joined by staff members, research workers and senior students, assembled in one of the large lecture theatres to hear an address by the Premier. The occasion was not a formal opening in the usual sense, because the new laboratories have in fact been in use for more than 18 months, occupation by Chemistry having proceeded gradually as each portion was finished by the builders.

The Premier and the Chancellor arriving in the Foyer of the Lecture Theatre Block

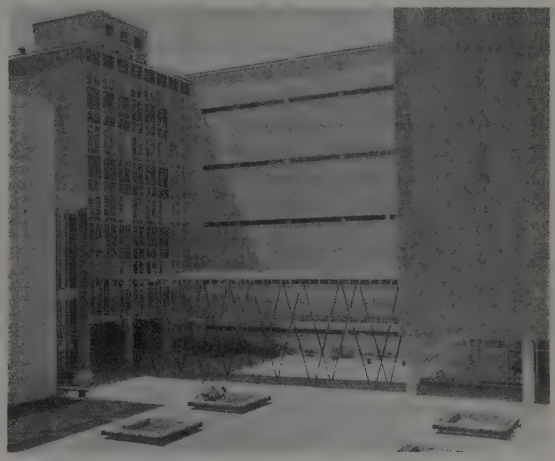
The Premier declares the building open

Mr Heffron traced the history of the present School from its origins in 1851, spoke in terms of appreciation

and congratulation of its development, achievements and status, enlarged on the general importance of chemical industry to the State of New South Wales, and outlined the financial responsibilities which his government has towards universities and education.

The number of students taking chemistry in the University of Sydney is growing rapidly; during the 1960 session the Chemistry School is providing facilities for about 2,700 students, of whom 2,260 are taking elementary chemistry. On 28 June undergraduate classes were not suspended, and the Chemistry School was working to its normal time-table; during the afternoon it was 'open' to the visitors. The Premier himself spent a considerable time in the elementary laboratories and talked with staff and students. Despite the possession of a newly completed building, first-year laboratory accommodation is already becoming an anxiety in the light of probable future student increases. It is gratifying, therefore, that the Premier showed keen interest in this particular point of the School's work, especially since his government has just set up a committee of enquiry on the adequacy, extension and coordination of existing provisions for higher education by the universities in New South Wales.

The photograph opposite shows a rear view of the New Chemistry School. One end of the Lecture Theatre block is seen on the extreme left. This block contains four lecture theatres, with total accommodation for about 1,000 students, writing rooms, foyers and so on. Part of the undergraduate block can be seen on the right; direct connection between this block and the Lecture Theatres is possible by the two-level covered way, or by corridors in the research wing, a portion of the back of which can be seen behind the covered way.



A rear view of the School

Since the rear of the building receives the north-west to west sunlight, it contains only the minimal window openings and is coated by off-white or light-grey aggregate panels. The square objects in the foreground are seats enclosing beds in which shade trees are being planted.

The New Chemistry School viewed from the north. It is interesting to compare this picture with the photograph of the model, taken before building commenced, also shown in this Journal (July, 1957, facing p. 505)

Book Reviews

THERMODYNAMICS AND STATISTICAL THERMODYNAMICS. J. G. Aston and J. J. Fritz. Pp. xiv + 556. *New York: John Wiley & Sons, Inc.; London: Chapman & Hall Ltd*, 1959. 66*s*.

This is not a book for the pedant but it most certainly is a book for the student. The authors reveal a deep and sympathetic understanding of the difficulties which undergraduates actually find when they try to master thermodynamics. Their concern is all with teaching. Judged in that light, as it should be, their book is outstanding. The experienced thermodynamicist will no doubt find parts of it useful but he should not try to read it right through. It is not meant for him. He will find the sequence irritating and the reiteration tedious. But for the undergraduate beginning the subject the one is admirably suitable and the other is, as every teacher knows, all too necessary.

Many teachers of thermodynamics will warm to this book, as I did, when they read in the preface: 'It has been our experience that lack of understanding of the First Law is often responsible for difficulty in using the Second Law'. They will discover the extent to which the authors' determination to make good that lack has been allowed to dominate the sequence and whole method of treatment in the earlier parts of the book. In particular the student is carefully and repeatedly taught (mostly by implication) to define the thermodynamic system he is talking about, and to distinguish the system from its surroundings, as for example in the clear exposition on p. 47 of Joule's experiment on the free expansion of gases.

The first 15 chapters deal with classical thermodynamics and the last eight with statistical thermodynamics. To have covered both these subjects in a single book of this size is a considerable and welcome achievement. It is not very surprising therefore to find that the statistical thermodynamics is limited to perfect gases and (briefly) crystals. It is perhaps more surprising that room *has* been found for a long chapter (pp. 61) on the energy levels of molecules, and a short chapter (pp. 14) on the calculation of the magnetic contribution to thermodynamic properties. In each of the two parts we are given not a single clear-cut logical treatment but a mixture of treatments, some historical, some restricted or lacking in rigour, and some general and rigorous, so as to 'allow the reader to compare some of the equivalent developments of the subject and to understand more advanced treatises'.

There are about 400 problems distributed throughout the text. Some of these are, of course, stock examples, but many are ingenious, entertaining and instructive. Roughly one-third of them involve the derivation of formulae stated without proof or only implied in the text. This trick of leaving the derivation of many of the formulae as exercises for the student not only saves space for more important things, but also is in itself a most useful pedagogical device. Once the principles are understood, the mathematical operations necessary for the formulation of thermodynamics are trivial; without an understanding of the principles all the mathematics in the Tripos will be of no avail. In my opinion there is no more important lesson than this for the aspiring thermodynamicist, nor do I know of any textbook from which this lesson emerges more clearly. A disadvantage of some of the best books on thermodynamics when viewed as textbooks for the undergraduate is that, however elegant they are and however suitable for the ideal student, in practice they encourage the real student to 'learn thermodynamics' by memorizing a collection of mathematical operations and formulae.

Those who have heard the senior author lecture will often recognize his voice in characteristically amusing asides (as on p. 114 and p. 313) and obviously deliberate anthropomorphisms (see p. 188 and p. 249 for two whoppers). These increase the feeling one always has while reading this book of personal contact with the authors, almost as though one were in the same room listening to them.

There are some places where errors or obscurities have crept in; a few examples follow. The statement of the Second Law on p. 1, 'It is impossible to convert heat into work at constant temperature', is incomplete and misleading, and is not corrected until p. 59. The criteria for a perfect gas are given on p. 51 as $PV = nRT$ *and* (my italics) $(\partial E/\partial V)_T = 0$ or $(\partial H/\partial P)_T = 0$. The first of these alone is a sufficient definition and implies the second and third.

On p. 69 it is implied that the formula for the entropy of mixing of perfect gases at constant T, P, can be derived from the first and second laws of thermodynamics. In fact it cannot be derived without recourse to statistical mechanics. Similarly the relation between chemical potential and partial pressure in a perfect gas mixture is introduced casually as though it were obvious. May be it is obvious, but the student should be told when an extra-thermodynamic assumption has been made.

The discussion on pp. 96–97 of equilibrium between two phases under different pressures is, to say the least, obscure. In particular, will not attempts to change the pressures by moving the pistons shown in Fig. 7.4–1 be nullified by evaporation or condensation?

On p. 156 there occurs the statement: 'positive or negative deviations [from Raoult's law] on the part of one component require deviations of the same sign by the other'. Certainly no such restriction is imposed by thermodynamics and there are in fact several contrary examples.

It is to be hoped that such errors and obscurities will be eliminated from the subsequent editions which will surely be needed. M. L. McGLASHAN

QUANTUM CHEMISTRY: METHODS AND APPLICATIONS. R. Daudel, R. Lefebvre and C. Moser. Pp. xiii + 572. *New York: Interscience Publishers Inc.; London: Interscience Publishers Ltd*, 1959. 116*s*.

This new book on quantum chemistry is in two parts of about equal length. The first is on the simpler quantum mechanical methods, mainly empirical, used in the study of molecules. The second part is on some more elaborate approximations and includes a fuller discussion of quantum-mechanical principles, bringing in quantum operators, the theory of angular momentum, electron spin and the theory of symmetry.

The book has been kept to a reasonable length by limiting the treatment to the electronic structure of molecules with fixed nuclei, and by leaving out the influence of external fields, vibration-electronic interaction and spin-orbit coupling. Both parts of the book begin with a statement of the required quantum-mechanical fundamentals and continue with a selection of illustrative topics and problems. As well as theories of π-electrons, which are given extensive and detailed attention in both sections, there are chapters on theoretical studies of bond angles, on bond, dissociation, resonance and ionization energies, on the theory of chemical reactivity and reaction rates, and on biochemical applications (carcinogenic power of conjugated molecules). The second part gives analyses of methods and results in one-electron systems, the helium atom, the hydrogen molecule and the orbital approximation. The other chapters give full discussions of many aspects of π-electron theory in unsaturated, aromatic and heterocyclic molecules, to which the authors have been substantial contributors.

One of the most difficult problems for the authors of a book on quantum chemistry is the balance between rigour in presenting arguments on the one hand, and giving persuasive and simple physical pictures on the other. Chemists want physical pictures to help them to visualize the electronic processes at work in real molecules, and to form good guesses as to how things might go in new cases of research interest. However, if the methods of quantum chemistry are to be used in a detailed way to make calculations, a more rigorous approach is essential. The authors of this book have a bias toward a more descriptive and pictorial presentation, especially in the first section of the book on empirical methods (300 pages). They have succeeded in combining this with an elementary description, with worked examples of how the simpler calculations (*e.g.* by the molecular-orbital theory) are actually made. These sections of the book are to be recommended for their detailed expository character. The chapters dealing with molecular-orbital theory are in this and other respects some of the best in the book.

This level of presentation is not so well suited to parts of the subject which need a more formal treatment. There are several chapters or portions of chapters which appear slipshod. For example, the subject of group theory in its application to symmetry problems does not lend itself to the authors' methods. One can use symmetry arguments armed only with simple prescriptions or recipes for using group-character tables, for finding direct-product representations and for writing down wave functions transforming like particular representations, and so on. There is much to be said for such a simple rule-of-thumb approach. Alternatively, to give a deeper insight, the formal basis can be developed in relation to the algebraic theory of groups, with proofs of the rather few theorems required to understand the more important properties of symmetry groups, their representations and their applications to the quantum mechanics of atomic and molecular systems. The authors fall between these extremes with a disorderly mixture of prescription and proof, unlikely to be helpful practically, and unsatisfactory from a formal point of view. More than 20 printed pages are devoted to spatial symmetry, starting with a half page given to a somewhat alarming 'proof' that a symmetry operator commutes with the Hamiltonian operator for the system. It is hard to see how a definition of a symmetry operator could be made which did not require that such operators leave the Hamiltonian invariant, and therefore by definition commute with it. On the important question of finding the irreducible representations contained in direct products formed in groups that have some degenerate representations, the authors make the confusing statement that this can be done 'by trial and error,' and do not give the simple formula by which it can be done directly. Elsewhere (pp. 445–447) they refer to *space* groups when *point* groups is the meaning intended. Also in an appendix on p. 539, in describing the expansion of a determinant, the authors use *minor* in the sense normally reserved for *cofactor*.

The book, as a whole, makes an uneven impression. Its treatment of applications fills a gap in the existing textbook literature but in fundamentals, and in descriptions of methods, it is often careless and not to be preferred to several earlier textbook presentations of these parts of the subject.

D. P. CRAIG

AN INTRODUCTION TO PRACTICAL INFRA-RED SPECTROSCOPY. A. D. Cross. Pp. vii + 80. *London: Butterworths Scientific Publications*, 1960. 17*s*. 6*d*.

The main text of *Practical Infra-red Spectroscopy* occupies less than 50 pages, and can easily be read in one evening. With the ever wider use of infra-red spectroscopy in organic chemistry the question of where a newcomer to the field should begin arises frequently; the answer is 'with Cross.'

The first part discusses infra-red instruments and techniques in a condensed form, at a level suitable for

those with access to a spectrometer and interested in its use and general results. It gives a useful guide to equipment for an intending purchaser. Supplemented by the instrument maker's own instructions, it contains information that would enable an inexperienced operator to obtain acceptable general spectra. Its advice is sound, up to date and practical, and there are a number of hints which may save even the expert from spending fruitless hours. For instance, there is a warning against the use of carbon disulphide as a solvent for examining $-NH_2$ frequencies.

Established workers will be more interested in Part II, which contains fuller characteristic frequency charts and tables than are available elsewhere. Even such copious charts and tables can only be taken as a guide, and detailed information must be sought in the original literature. It is a great pity that this section does not give full references, especially as there are a few entries of questionable reliability.

Nevertheless the book can be strongly recommended and should be part of the library associated with every infra-red section.

D. H. WHIFFEN

PLASMA PHYSICS. J. G. Linhart. Pp. xi + 278. *Amsterdam: North-Holland Publishing Co.*, 1960. 50*s*.

BASIC DATA OF PLASMA PHYSICS. S. C. Brown. Pp. viii + 336. *New York: John Wiley & Sons Inc.; London: Chapman & Hall Ltd*, 1959. 52*s*.

A glimpse of the titles of these two books might convey the impression that they had subject matter in common, whereas in fact it would be difficult for the reader to find any resemblance so far as the matter dealt with is concerned. One of them is a rather sophisticated work of high-level physics, while the other is a rather dressed-up 'hand-out' of notes to students taking a course of graduate lectures. Nevertheless, it will be seen that they have their similarities.

The term 'plasma' was first applied by Langmuir to denote a system of many free electrons and ionized atoms where the mutual Coulomb interactions cannot be disregarded. The topic of 'plasma physics' deals with the properties of such systems as a whole. Although related to many other branches of physics, it was a somewhat esoteric study until it became of immense practical importance in connection with controlled nuclear fusion as a source of power, and with magneto-hydrodynamics.

Dr Linhart's book provides an elegant and serious introduction to plasma physics in this sense. The first half of the book is essentially theoretical, and opens with a mathematical treatment of the motions of electrons and ions in various types of electric and magnetic fields. Particular reference is made to the constraint of particles by various fields, and to radiation (Bremstrahlung, cyclotron, Čerenkov) from accelerated charges. Succeeding chapters of this part of the book take up the theory of plasmas as fluids, with a statistical-mechanical description, and lead to accounts of the properties of waves, instabilities and shock waves in plasmas. A particularly interesting section is that dealing with 'plasmoids'—that is, individual clouds of plasma—and their interactions. The relation to conventional hydrodynamics is stressed. The whole treatment is mathematical, and of a kind chemists are likely to find difficult.

The second half of the book deals with applications, by far the most important of which is the development of controlled nuclear fusion. A very clear introduction to sources of nuclear energy (not itself a branch of plasma physics) leads on to the discussion of the control of the plasmas which can be obtained from them. The direction of the theoretical treatment is very evidently thought to be useful here, in its application to the constraint of plasmas by pinch effects and other devices. Finally, short sections are devoted to the use of plasmas in generating electromagnetic waves, in the conversion of chemical energy directly to electrical energy, to particle acceleration and to rocket propulsion. The whole book provides an admirable, if laconic, summary to a vast and important field of work of great topical interest.

The material of Dr Brown's book is concerned mainly with the topic of gas discharges and related phenomena. Much of this material is of at least marginal interest to many physical chemists, concerned as it is with such matters as elastic and inelastic collisions of electrons and ions with neutral atoms and molecules. These are dealt with by Dr Brown first of all from the cross-sectional aspect of single collisions, and then from the point of view of the diffusion and mobility of electrons. Sections on electron attachment, recombination and surface ionization lead on to discussions of breakdown, arcs and various types of discharge. Many of these fields of study, all involving relatively small amounts of energy, are both fascinating and difficult, and often remarkably obscure. Plasmas containing a preponderance of neutral molecules, although not so spectacular and not so 'cosmic' as those discussed by Dr Linhart in which a neutral particle is about as rare as a free electron in a glass of water, still offer many challenges both from the theoretical and practical aspects.

Dr Brown's book is clearly a very useful one. Nevertheless, its note form makes it irritating to read. Is it really necessary to interrupt a sentence with 12 or more pages of diagrams (pp. 5–16, 227–239)? The presentation of mathematical formulae, although accurate, lacks clarity, giving the impression of a triumph of amateur typewriting but not of the possibilities of modern type-setting. As a monograph the book tends to be uncritical, although one can see that combined with a course of lectures a critical element could be introduced. The great value of a work of this kind lies in its extensive referencing and its classification

of the material. From both of these aspects it can be recommended highly.

T. M. SUGDEN

OPTISCHE DATEN ZUR BESTIMMUNG ANORGANISCHER SUBSTANZEN MIT DEM POLARISATIONS MIKROSKOP. E. Kordes and K. Recker. Pp. xi + 192. *Weinheim: Verlag Chemie GmbH*, 1960. DM 43.

This book deals with the identification (*not* determination) of transparent inorganic substances by the polarizing microscope. (A corresponding book for organic compounds is that by A. N. Winchell, *The Optical Properties of Organic Compounds*, 2nd edn, New York, 1954). The book is concerned primarily with the identification of substances in powder form.

There is a 28-page introduction to explain the principles of the method to the non-specialist, with two pages of coloured illustrations of the characteristic interference patterns (these can be bought separately for teaching purposes if required). The remainder of the book consists of tables; there are 78 pages of tables of substances, first classified as isotropic, uni-axial and bi-axial, and then within each table in order of increasing refractive index. These tables give many physical properties and also references to other sources of information. The next 60 pages are devoted to tables for determination, again classified under isotropic, uni-axial and bi-axial, with optical properties systematically arranged.

The eight diagrams on five loose sheets included in a pocket at the end of the book serve for ready reference. For each group of compounds the reference numbers are shown on co-ordinate diagrams, in which refractive index, double refraction and density are related in various combinations. Over 1,250 compounds in all are included in the work; the indexes cover names of minerals and formulae alphabetically arranged.

The polarizing microscope provides a powerful tool for the qualitative analysis of heterogeneous mixtures of solids, and this book will be a most valuable source of reference in the inorganic field.

W. KLYNE

THE HARVEY LECTURES. Series LIV. Delivered under the Auspices of the Harvey Society of New York 1958–1959. Pp. xiv + 312. *New York: Academic Press Inc.; London: Academic Books Ltd*, 1960. $7.50, 60*s*.

The recent publicity by the B.B.C. and newspapers of current developments in our knowledge of proteins and nucleoproteins has drawn popular attention to the importance of the relationship between the synthesis of protein and nucleoprotein structure. In the 1958–59 series of Harvey Lectures, Zamecnik's contribution is therefore of particular interest to chemists in providing a more satisfying and up-to-date account of this fascinating story. Protein synthesis involves three distinct steps; amino acid activation by reaction with adenosine triphosphate to form amino acyl adenylate, sequence determination and peptide formation and finally completion of the secondary and tertiary structure. Views on the role of the ribonucleoprotein particles in the cell microsomes, in acting as template for designating the sequences of activated amino acids before the polypeptide synthesizing step, are clearly described. The evidence that separate ribonucleic acid molecules are individually coded for each amino acid is fully surveyed.

The carotenoid pigments are now believed to play a part in providing an additional means of trapping light energy to be used ultimately for photosynthesis. The high efficiency of the transfer of energy from the carotenoid to the chlorophyll system is thought to indicate a close association at the molecular level between the two groups of pigments. Stanier has discussed the probable routes of biosynthesis of these pigments. Although mevalonic acid, the C_5 isoprenoid precursor of the sterols, has been demonstrated to be a precursor of β-carotene, the evidence for its role in the biosynthesis of other carotenoids is less direct. Nevertheless, it seems likely that eight units of mevalonic acid are concerned with the formation of C_{40} phytoene, which is probably the precursor of the carotenoids. By careful studies of mutant forms of carotenoid-synthesizing fungi and micro-organisms, evidence has been obtained of the pathways concerned with the introduction of the additional double bonds with phytoene, necessary for the formation of these pigments.

Buchanan had described the detailed enzymic synthesis of purine nucleotides. For the synthesis of the inosinic acid, the parent nucleotide from which the others are derived, seven moles of adenosine triphosphate are required. Two of these are required for the activation of formate as a derivative of tetrahydrofolic acid; the others are required for the synthesis of the purine skeleton from this compound, carbon dioxide, glycine, ribose-5-phosphate, glutamine and aspartic acid.

Wigglesworth emphasized that all animals are polymorphic, in that a number of recognizable forms are present in a single species. After pointing out that sex is a genetically-controlled dimorphism controlled by the sex chromosomes and autosomes within the nucleus, he discusses the hormones controlling the growth of larvae and metamorphosis.

Biological and physiological papers are concerned with the genetic control of viral function and methods of approach to the problems of behaviour. The excretory function of the liver is described by Bradley, who mentions a possible counter-current system in the liver with blood and bile flowing in parallel channels in opposite directions. Eagle emphasizes the fundamental importance of determination of the factors responsible for the losses of biochemical function in growing cell cultures. The lecture by Kuffler on the

excitation and inhibition in single nerve cells in the lobster and crayfish is of considerable interest to the pure physiologist.

This volume will be much enjoyed by interested persons who were not privileged to hear the Lectures.

C. H. GRAY

METHODEN DER ORGANISCHEN CHEMIE (HOUBEN-WEYL). VOLUME V. PART 4. HALOGEN-VERBINDUNGEN. Edited by E. Müller. Pp. xlvii + 894. *Stuttgart: Georg Thieme Verlag*, 1960. DM 180.

The organic chemist has many reviews and monographs, reports and handbooks to guide him and to direct his steps towards original literature, both theoretical and experimental. A few will occur to everyone—*Chemical Reviews*, *Quarterly Reviews*, *Annual Reports on the Progress of Chemistry*, *Organic Syntheses*, *Organic Reactions* and similar publications dealing with biochemistry. Finally Meyer and Jacobson's unique *Lehrbuch* serves to remind him that quite an appreciable amount of work in organic chemistry had been published before, say, the Treaty of Versailles.

The new edition of Houben-Weyl combines many of the best features of all these standard authorities. It portrays the present, it delves into the past, it presents facts, outlines theories and suggests explanations; it is at the same time a book of recipes and a mental stimulus. The completeness of the information which this volume supplies renders unnecessary any summary of its contents. A few reactions and features which, owing to the reviewer's personal interests, appear specially attractive may, however, be mentioned.

Former members of the Department of Chemistry in the University of Manchester will read with sincere pleasure Professor Roedig's remark on p. 171 : 'it should be noted that the enol hypothesis of the halogenation of aldehydes, ketones, carboxylic acids and their derivatives formulated originally by Lapworth, has, in spite of various criticisms, held its own with little modification up to the present day.' Equally happy is the inclusion, immediately following the citation of Lapworth's work, of several references to Dawson's researches at Leeds. K. H. Meyer's name follows. The reviewer recalls his seeing for the first time, in a colloquium at Göttingen in 1912, a demonstration of Meyer's acetoacetate–bromine-water–ferric chloride reaction in which 'the hydrogen visibly walks across from carbon to oxygen'. This 'striking lecture experiment' is mentioned in *J. chem. Soc. Abstr.*, 1911, **120**, i, 835. It can readily be shown to students in discussions at their laboratory bench and is always appreciated.

The isolation by Calingaert in 1952 of benzene tetrachloride (3,4,5,6-tetrachlorocyclohexene) from the products of the photochlorination of benzene is most interesting, and is cited in an account of the preparation of benzene hexabromide. The addition of dibromocarbene CBr_2 to olefins to give 1,1-dibromocyclopropane derivatives affords a beautiful explanation of the well-known ring expansion of pyrrole to 3-bromopyridine, of indene to 2-bromonaphthalene and of indoles to quinolines in presence of bromoform and potassium hydroxide. Another new reaction is 'carbobromination' which occurs when oxalyl bromide reacts with the bromides of saturated aliphatic acids thus: $R{\cdot}CH_2{\cdot}CO{\cdot}Br + Br{\cdot}CO{\cdot}CO{\cdot}Br = R{\cdot}CH(COBr)_2 + CO + HBr$. The action of bromine on aromatic organo-metallic or -metalloidal compounds to give nuclear bromo-derivatives is illustrated mainly with magnesium, lithium and mercury. This reaction was used by Vorländer in Halle and Rothstein in Leeds in the orientation of the nitration products of aromatic derivatives of mercury, thallium, tin, lead, bismuth and also boron. The description of early and recent work on multivalent iodine is fascinating. The remarkable extension of the subject by Masson at Durham receives full recognition.

Alkyl hypobromites and hypo-iodites ($R{\cdot}O{\cdot}X$) can be added to olefins. Nitrogen iodide $NH_3{\cdot}NI_3$ (which polarizes thus : $\overset{-}{N}H_3\overset{+}{N}I_3$) in alcoholic solution is a convenient source of ethyl hypoiodite :

$$NI_3 + 3C_2H_5{\cdot}OH = NH_3 + 3C_2H_5{\cdot}OI.$$

FREDERICK CHALLENGER

POLYSACCHARIDES OF MICRO-ORGANISMS. M. Stacey and S. A. Barker. Pp. ix + 228. *Clarendon Press: Oxford University Press*, 1960. 30*s*.

This book contains a short introduction by the authors, 12 chapters, two appendixes and an index. As stated in the introduction, the first five chapters are intended for the non-specialist, and deal with 'modern techniques for the isolation, purification and complete structural determination of complex polysaccharides such as occur in micro-organisms'. They also cover carbohydrate nomenclature, monosaccharide components and the functions of polysaccharides. The second chapter is concerned with the monosaccharide components, the structures of about 20 of which are shown in tabular form. Also tabulated in this chapter are the names, structures and sources of those rare sugars, synthesized by micro-organisms and incorporated by them into well-known antibiotic molecules. The authors suggest that these rare sugars may eventually be shown to be present in polysaccharides. The several recognized pathways for the biosynthesis of sugars and their derivatives are also briefly outlined. Chapter V, rather unhappily entitled 'Structural Determination of Polysaccharides', gives in 30 pages a lucid, if very condensed, account of the various techniques now available for the elucidation of the fine structure of polysaccharides.

These early chapters amount to a little less than one-third of the book, and in attempting to describe fields about which a vast literature has grown they are necessarily a little scrappy. Nevertheless the authors have

managed to convey an astonishing amount of information in a small space.

The subsequent chapters deal with polysaccharides of rickettsiae and viruses, Gram-negative and Gram-positive bacteria, higher bacteria, moulds, yeasts and yeast-like fungi and protozoa. The higher bacteria include mycobacteria, actinomyces, nocardia, streptomyces, micromonospora and leptospira. Appendix I contains a list of 29 monosaccharidic materials present in micro-organisms, together with their respective melting points, rotational data and a literature reference for each substance. As few of the references given at the ends of the chapters are more recent than 1957, later reports, most of which appeared in 1959, are covered in Appendix II.

This is a beautifully produced book, clearly printed, free from typographical errors and furnished with elegantly set-out formulae. To have succeeded in such a small volume in giving so much information about the chemical, immunological and medical aspects of the polysaccharides of microbes and to have done it so clearly is a considerable achievement. As prices range nowadays this is an inexpensive book and will be of great value to anybody interested in the chemistry and biological properties of microbial polysaccharides. The publishers and authors are to be congratulated.

V. C. BARRY

ORGANOSILICON COMPOUNDS. C. Eaborn. Pp. x + 530. *London: Butterworths Scientific Publications*, 1960. 80*s*.

The industrial importance of silicone polymers has stimulated much recent research work, and there are a number of earlier books on silicones and organometallic compounds, several of American origin. Dr Eaborn's book is the first comprehensive account of organosilicon compounds from the theoretical aspect; it contains many new assemblies of facts previously dispersed throughout the literature.

The book is intended primarily for research workers in organosilicon chemistry and related fields, and as a reference book for those engaged in industrial applications of these materials. Much factual matter is presented as tables (76), formulae and equations, and the whole is very well documented. There are over 2,000 references, which cover the subject up to the second half of 1958, and several papers published in 1959 are also mentioned. The author is to be congratulated on his success in the immense task of collecting and arranging so much information in the form of readily comprehensible tables and the like. It is a task which often is now attempted only by a group of writers. Reaction mechanisms have been given prominence, and the discussion is fully supported by the relevant experimental facts.

The main chapters deal with methods of forming Si–C bonds, and their reactions, organosilicon halides and hydrides, compounds containing Si–O, Si–S, Si–N and Si–Si bonds, carbon-functional organosilicon compounds and silicones. In spite of the theoretical approach there is much of experimental importance, including a chapter on determination of silicon and those elements and groups most frequently associated with it in organosilicon compounds.

There are a few errors of emphasis in the section on silicones, but this is not unexpected in a subject which is expanding so rapidly and in which much detailed information remains secret, or is disclosed only in patent claims. Our knowledge is perhaps expanding fastest in the field of carbon-functional organosilicon compounds; for this reason it is regrettable that space did not permit reproduction of the tables from the important review by George, Prober and Elliott.

These are, however, minor criticisms of an excellent book which will undoubtedly become an essential source of information for those engaged on research in this field or on its industrial applications. As a reference book, its value would have been enhanced by the inclusion of a separate index of compounds. The tables, equations and text are clearly printed, and the book is very well produced. Its price is reasonable for a book of this scope.

G. G. FREEMAN

THE MANUFACTURE OF SULFURIC ACID. A.C.S. Monograph No. 144. Edited by W. W. Duecker and J. R. West. Pp. viii + 515. *New York: Reinhold Publishing Corporation; London: Chapman & Hall Ltd*, 1959. 100*s*.

This work is the long awaited replacement of Fairlie's *Sulfuric Acid Manufacture*.

The monograph consists of contributions by several specialists, and covers the subject with emphasis on American practice and the use of brimstone as raw material. This bias is especially marked in the short section dealing with 'Other Raw Materials' in which anhydrite, spent oxide, hydrogen sulphide and petroleum sludge acid are dismissed in one and a half pages.

The diminished importance of the chamber process is reflected in the single essay on this subject which deals with the theory and describes the modern tower systems.

An excellent chapter on the theory of the contact sulphuric acid process is followed by a very good account of contact masses in practical use but which repeats some of the previous contribution. A discussion of the practical aspects of the contact sulphuric acid plant ends with summarized descriptions of some modern contact plants. This is followed by sections describing three major designs of American contact plants, and it is unfortunate that a section dealing with European designs has not been included in place of the duplicated material. A useful chapter on health and safety hazards omits any reference to the explosion hazard associated

with sulphur dust; a brief mention of this danger is made in the early chapter on raw materials. The chapter dealing with health and safety also describes relevant methods of analysis which could have been incorporated in the later chapter devoted to analytical procedure. In this section no mention is made of Flint's method for determining low concentrations of SO_3 in the presence of SO_2. The contribution on handling, storing and shipping contains the frequently used specific gravity and concentration table which would be more conveniently accessible in the appendix with the other properties of sulphuric acid.

A section on economics of the sulphuric acid industry discusses a number of factors to be considered when deciding the type of plant to be built. The relative importance of these factors differs in American and European practice; prevailing conditions in Europe make it essential to treat the sulphur dioxide in smelter gases, and the value of pyrites calcines is of importance.

Some minor typographical errors mar the otherwise high standard associated with the A.C.S. monographs.

A work of this magnitude would be strengthened by a section dealing with the chemical engineering aspects of the operations involved in manufacture.

The bibliographies conveniently collected together at the end of each chapter and the appendixes on the properties of sulphuric acid, oleum, sulphur trioxide, sulphur, air and materials of construction are particularly valuable features of this work, which will replace 'Fairlie' as the best available work in English on sulphuric acid.

W. R. WIGGINS

A STATISTICAL MANUAL FOR CHEMISTS. E. L. Bauer. Pp. x + 156. *New York: Academic Press Inc.; London: Academic Books Ltd*, 1960. $4.75, 38*s*.

In his preface the author states: '[This book] is not meant to be a complete text on statistical techniques, but rather a manual for the working chemist', and 'It is my hope that this manual will serve as a statistical primer; having mastered the fundamentals, the reader will be prepared to graduate to the more complex techniques as the need arises'. The requirements that must be met by the two types of book named in these passages are by no means the same, though they overlap. The 'working chemist' expects to find in his manual a detailed account of those methods that are most suitable for his data, whether or not they are considered standard in other fields of application, whereas the reader of a primer needs to be introduced to the truly fundamental and standard methods, and to be told, above all, *why* those methods are used. Clearly, though a reasonable attempt at either approach might be made in a book of this length, it is unreasonable to expect to satisfy both sets of requirements, and this book is definitely not suitable for use as a primer. Many of the methods described are of the type uncharitably known as 'quick and dirty'. Some of these are very suitable to data of the type discussed, but their study is unlikely to lead to a sound appreciation of more advanced methods. Also, there is throughout a lack of logical precision: by this I do not mean the omission of mathematical derivations (which is perfectly legitimate in a book of this type), but a vagueness in the definition and use of fundamental terms such as 'probability' and 'significant'. The discussion of the meaning of significance testing contains several ambiguities, and one or two definite mis-statements, and seems likely to confuse the reader rather than to enlighten him.

Unfortunately the book is also unsatisfactory as a working manual. Many of the methods described are based on the use of range to estimate variability. This procedure is often appropriate, and the methods for simple sets of data are explained reasonably well. However, these methods become rather confusing when applied to more complicated experiments (and are almost as laborious as the more orthodox procedures, for data of the type used). The rules for their use are not clearly stated, and on at least two occasions the author himself is led into error. The method given on p. 66, for the calculation of a three-factor interaction, is incorrect, and is effectively equivalent to the method given previously for calculating one of the two-factor interactions. The method on p. 129 for calculating limits to a ratio is doubly wrong, as it ignores the variability of the denominator and makes an incorrect use of the range (correct use gives limits almost identical with those given by the standard procedure, and about twice as wide as those obtained by the author).

Further criticisms could be made if space permitted. With regret, I cannot recommend this book. There is room for a really short practical work on statistics for chemists, and, had the author's intentions been rather more satisfactorily carried out, his book would have gone far towards filling the need.

M. R. SAMPFORD

INORGANIC CHEMISTRY. J. Kleinberg, W. J. Argersinger and E. Griswold. Pp. viii + 680. *Boston: D. C. Heath & Co.; London: George G. Harrap & Co. Ltd*, 1960. 75*s*.

An important feature of several new textbooks of inorganic chemistry, published recently as a result of the marked revival of interest in this subject in the last decade, is an approach from a theoretical viewpoint. Chemical phenomena must now be described in terms of quantum mechanics and atomic physics. This new book from America provides an example of this approach. The first two parts (pp. 287) give a general theoretical introduction, and the chemistry of the elements is described in the third part.

Atomic structure, and properties of the elements, such as ionic radius, covalent radius, ionization potential, electron affinity, electronegativity, electrode potential and magnetic susceptibility, are discussed in the first

four chapters. The theory of wave mechanics is explained and used from an early stage, and consequently it seems rather unnecessary to devote as many as ten pages to a discussion of the Bohr theory of the atom. The final chapter of Part I is concerned with ionic and covalent bonding. It also deals briefly with the hydrogen bond, and very briefly with the metallic bond. Part II consists of a short but valuable chapter on the properties, isomerism, structures, types of bonding and stability of co-ordination compounds, and a second chapter on theories of acids and bases and reactions in non-aqueous systems.

These early chapters provide a very necessary basis for a proper understanding of the chemistry of the elements, which is described in the remainder of the book. In general, Part III contains a very satisfactory selection of material, which is used to illustrate the characteristic relationships of groups of elements. Particularly useful are the chapters on the transition elements in which the known oxidation states are used as sub-headings. Industrial processes and the occurrence of the elements are given only scant treatment.

In the preface the authors explain why they have not discussed nuclear chemistry, the inert gases and organometallic compounds. The omission of nuclear chemistry is rather surprising in a textbook of inorganic chemistry published in 1960, and it may be that some students will prefer to buy one of the less expensive books which does include this topic. A further serious omission must be pointed out. Although structural diagrams of many covalent molecules are given (incidentally, the HON bond angle of 90° shown in the structure of nitric acid on page 401 is surely not correct), the whole book contains only *two* illustrations of the structures of solids; these are for diamond and graphite. At this level a reader might expect to be shown the spatial arrangement of atoms or ions in rock salt, caesium chloride, fluorite, rutile, zinc blende, wurtzite and cadmium iodide structures, together with drawings illustrating cubic and hexagonal close packing.

A helpful feature of this well-presented book is seen in the lists of references to other books which are given at the beginning of each chapter. This book is suitable for ordinary degree students, and in some respects will be useful for Honours degree students and those taking Part II of the Graduate Membership Examination. It should find a place in every technical teaching library.

M. J. FRAZER

QUALITATIVE ANALYSIS AND ELECTROLYTIC SOLUTIONS. E. J. King. Pp. xxi + 641. *New York: Harcourt, Brace & Company, Inc.*, 1959. $7.25, 58*s*.

Many teachers in schools, technical colleges and universities must have debated whether the amount of time their students devote to classical qualitative analysis is justifiable. Professor King, in a lengthy preface, argues that qualitative analysis provides a remarkably appropriate setting for the teaching of chemical principles, especially those concerned with equilibria in aqueous solutions, and his treatment of this theme is such that all who teach that subject should read this book.

The first fifteen chapters (pp. 300) cover such topics as the structures of inorganic compounds, ionic equilibria (including ion-association), co-ordination compounds, solution kinetics, the colloidal state, thermodynamics and the theory of acids and bases. A large number of problems are given, and answers to numerical ones are provided. Much of the material presented may, of course, be found in any standard textbook of physical chemistry; the particular merit of this book lies in the application of the material to familiar and important examples, and the physico-chemical background of analytical processes is emphasized throughout.

The same care in presenting qualitative analysis as part of chemistry in general is apparent in the practical part of the book (pp. 260). Groups of cations and anions are discussed in turn, each separation table being prefixed by a substantial and lucid account of the chemistry of the elements concerned. Many numerical data are given, and the student is encouraged to think in terms of competing equilibria. There are very few mistakes (the description of the structure of cupric oxide on p. 393 is the only major one noticed), and the author's attempt to write a book which will relate work in the laboratory to that in the lecture room must be considered successful. The scope of the qualitative work in the courses for which this text was written is, however, by English standards woefully inadequate, being only of G.C.E. 'A' level, and for this reason the book is likely to be popular in this country as a stimulant to teachers rather than as an analytical handbook for students.

Paper and printing are of good quality, and a special word of praise is due for the excellence of the index.

A. G. SHARPE

WASTE TREATMENT. Second Symposium on the Treatment of Waste Water. P. C. G. Isaac. Pp. xii + 477. *Oxford: Pergamon Press Ltd*, 1960. 84*s*.

It might be thought that the various courses, conferences and symposia on waste-water treatment held in recent years would have exhausted discussion of this subject, but even increased interest is indicated by the strong support given to the gathering held in King's College, University of Durham, during 1959.

The principal topics covered in this Symposium were the theory and practice of biological treatment, and the treatment and disposal of solids separated from effluents, four of the 21 papers being contributed by eminent foreign experts. The standard of the contributions, as well as the discussions (summaries of which are given at

the end of each paper), is high. One paper, which surveys the ecology of activated sludge and bacteria beds, is perhaps the most comprehensive single review of this subject that has yet appeared in the English language; a very interesting point dealt with is the design and operation of bacteria beds with the object of preventing excess film growth. It is rather a pity that the précis of the discussion of this particular contribution is so short. This paper, together with a very practical one dealing with the application of effluent recirculation to biological filtration, ought to be read by everyone faced with the task of designing a bacteria-bed scheme. The design of biological oxidation plant from biochemical oxidation demand data and oxygen transfer rates, dealt with by Eckenfelder and McCabe, is interesting because it illustrates the American and Continental practice of designing treatment plants based on such factors, in contrast to the more conservative (but nevertheless reliable) British methods.

Detailed consideration of recent development work on the various systems of activated-sludge treatment is confined to brush aeration—a method which, although simple and satisfactory to operate, has not yet been used extensively in Britain. The inclusion of a review of factors involved in the control of trade-effluent discharges to sewers, and of methods used by local authorities to establish charges for treating such wastes, is commended because it will be valuable to municipal officers and manufacturers alike. The specific treatments of effluents from distilleries, food canning and freezing industries, tanneries and milk-product factories are authoritatively considered in other contributions. Many aspects of sludge treatment and disposal are thoroughly discussed in several articles. Reliable data for the design of sludge digestion tanks are given in the paper by Griffiths, whereas capacities quoted by Simpson (p. 39) for digestion at 60°F would be insufficient for British conditions.

The volume is one for the specialist rather than for the beginner, and can be classed amongst the best literature on waste-water treatment.

J. McNICHOLAS

RAPID STATISTICAL CALCULATIONS. M. H. Quenouille. Pp. xv + 35. *London: Charles Griffin & Co. Ltd*, 1959. 10*s*.

In times of stress, it is common enough to adopt chemical techniques that are less demanding in terms of apparatus and manpower than those ideally suited to the task in hand. These less refined methods may lead to predictions having an imprecision greater than that attainable under perfect conditions. Nevertheless the chemical tools used will probably be quite adequate for the particular job. Strangely this argument is not generally considered when the process of evaluating the results is undertaken. But it will be readily acknowledged that a shortage of time or calculating machinery frequently hinders the chemist who wishes to press on with his next batch of experiments. Then is the time to take up the book reviewed here.

Mr Quenouille shows us how to use mathematical tools—some of them blunter than usual—for the rapid treatment of experimental data. Several of the techniques advocated are independent of the form of the sampled population, *i.e.* 'normality' is not assumed.

The subject matter is divided into three parts. Measures of location and dispersion are considered first, together with methods for comparing two or more groups of observations. The second section deals with comparisons of frequencies and proportions, and the final one with associated measurements. In the final section the graphical methods for dealing with association and regression are particularly valuable. Although comprehensive, the selection of methods is not so great that it will confuse the reader. The book fulfils its author's intention in being easy to use; each method is explained in detail on two facing pages. The publishers too have played their part in producing a robust edition of pocket size.

This book should be of considerable use therefore to all who have to evaluate results in any experimental science.

B. J. WALBY

PUBLICATIONS RECEIVED

INTERNATIONAL COMMISSION FOR UNIFORM METHODS OF SUGAR ANALYSIS. Pp. vii + 130. Report of the Proceedings of the Twelfth Session, Washington, 1958. *Obtainable from Dr D. Gross, Hon. Secretary, ICUMSA, Tate & Lyle Research Laboratories, Westerham Road, Keston, Kent.* 25*s*.

BRITISH STANDARDS

791 : 1959. Bomb Calorimeter Thermometers. Pp. 11. 4*s*.

1428 : Part A2 : 1959. Nitrogen Combustion Train (Micro-Dumas). Microchemical Apparatus. Pp. 15. 4*s*. 6*d*.

1428 : Part A4 : 1960. Halogens and Sulphur Combustion Train (Micro-Grote). Microchemical Apparatus. Pp. 11. 4*s*.

3203 : 1959. Recommendations on Laboratory Furniture and Fittings. Pp. 111. 25*s*. net.

903 : Part A 13 : 1960. Methods of Testing Vulcanized Rubber. Determination of Resistance to Low Temperatures (Rigidity Modulus Test). Pp. 14. 4*s*. 6*d*. net.

903 : Part B 11 and B 12 : 1960. Methods of Testing Vulcanized Rubber. Rubber (Polymer) Determinations. Pp. 17. 5*s*. net.

1428 : Part H 1 : 1960. Specification for Weighing Vessels for Microchemical Analysis. Microchemical Apparatus. Pp. 8. 3*s*. net.

Institute Affairs

On 18 July, Mr E. LeQ. Herbert, *President* (*right*), presented a congratulatory address to the Royal Society on behalf of the Officers, Fellows and Associates of the Institute. Sir Lindor Brown, C.B.E., Biological Secretary, Royal Society, received the Address, in company with Professor Wilson Smith, Vice-President and Member of Council, Royal Society (*see J.*, 271).

EXAMINATIONS, JANUARY, 1961

Graduate Membership, Part I.—An examination will be held on Monday and Tuesday, 9 and 10 January, 1961, in London, and elsewhere at the discretion of the Council.

Candidates who have not yet been accepted for examination should obtain from the Assistant Registrar without delay the prescribed Application Form so as to allow ample time to secure thereon the necessary signatures certifying their courses of taining. **The completed Application Form must reach the Institute not later than Monday, 10 October, 1960.** No application in respect of the January examination will be accepted if received after that date.

Entry forms will be sent as soon as they are ready to accepted candidates. **The last date for the return of Entry Forms will be Wednesday, 9 November, 1960.** No entry will be accepted if received after that date.

Graduate Membership, Part II.—The theoretical section of the examination—Part II(*a*)—will be held in London, and if required, in other centres, on Monday and Tuesday, 9 and 10 January, 1961.

The practical section of the examination—Part II(*b*)—will be held in London on Wednesday to Saturday 11 to 14 January inclusive, and Tuesday to Friday, 17 to 20 January, 1961, inclusive.

Candidates will be asked to state their preference as to the centre for their theoretical papers, and the period for their practical examination, but it must be clearly understood that no guarantee can be given that their wishes will be met.

Last dates for application and for entry are the same as for the Graduate Membership Part I examination (*see* above).

Diplomas in Applied Chemistry: Branches D and E.—Examinations will be held in the week beginning Monday, 13 February, 1961 in London. Last dates for application and for entry are the same as for the Graduate Membership examination (*see* above).

EXAMINATIONS, JUNE, 1960

Graduate Membership, Part I

Examiners: Dr C. C. Addison, Dr D. J. G. Ives, Dr F. G. Mann.

The examination was held at Chelsea College of Science and Technology, London, and at various local centres in the period 20 to 21 June, 1960.

The total number of candidates was 404, of whom 183 passed (45·3 per cent).

Of the 404 candidates, 33 had taken full-time courses, and of these 20 passed (60·6 per cent); nine of the 12 who attended sandwich courses passed (75 per cent); 46 attended part-time courses preceded or followed by a period of full-time or sandwich study, and 27 passed (58·7 per cent). Of the 313 who received their training entirely by part-time courses, 127 were successful (40·6 per cent).

Graduate Membership, Part II

Special Relationship Scheme

Assessors: Professor C. W. Davies, Professor W. G. Overend, Dr A. G. Sharpe.

The examination was held in each of the five Colleges in Special Relationship with the Institute in June, 1960. Each college set its own examination papers, which were moderated by the Institute's Assessors, who also acted as external examiners in respect of the marked scripts.

There were 112 candidates, of whom 58 passed (52 per cent).

Of the 112 candidates, 34 had previously passed Part I and of these 19 passed Part II (56 per cent); 33 candidates had been exempted from Part I under the provisions of Regulation F3 and of these 22 passed Part II (67 per cent); of the three candidates who had been exempted from Part I by virtue of holding a B.Sc. degree which included chemistry as a principal subject, one passed Part II (33 per cent). Also 42 candidates had not passed any of these 'hurdles' and 16 of them passed Part II (38 per cent).

PASS LIST: PART II

Birmingham College of Advanced Technology

BENNETT, John Vincent
CLAMP, Anthony Charles
DAVIS, John Hatfield
MARSH, Barry John
MOLE, Maurice Frederick
NICE, James Patrick
SMITH, Jack, A.C.T. (BIRM.)

Bristol College of Technology

BELSTEN, John Charles
GALVIN, Hubert Patrick Caldicote
HOLLOWAY, Clive Edward
JACKSON, Albert Edward
MADGE, Derek Francis
PEARCE, Royston John
PHELPS, Brian Ernest
POARCH, Robert
RICHARDSON, John
SLAVIN, Robert
THAYER, John Michael

Kingston-upon-Hull College of Technology

ASTROP, David George
BRATT, Ronald
GARDNER, Leslie
MEDCALFE, Terence
PAGE, Leslie Sherwood

Liverpool College of Technology

DEAN, Ronald Richard
DEWHURST, Brian Bernard
ELLIS, Raymond John
GILSON, Ian Trevor
GRACE, John Charles
GRIFFITHS, William Eric
HIGNETT, Leslie Donald
HOLLAND, Frank Stanley
ILES, Brian Rodney
JONES, Kenneth
MCCANN, Vincent Bernard
MILEY, David
SHERRY, Peter Edward
WILLIAMS, Brian Hugh

Salford, Royal Technical College

BODEN, David Paul
BOOTH, Peter
BRANDON, Derek
CAPENER, Ralph Oscar, A.M.C.T.
EVANS, Clifford
EVANS, John Delwyn
GREEN, Geoffrey
GREEN, Victor
GUY, George Bruce
HEARN, Donald
HOPKINS, Frank
KERNICK, William
MOLYNEUX, Alan
MORGAN, Paul Felton
NIXON, Norbert
OGDEN, John Ronald
PERCIVAL, Sidney Joseph, A.M.C.T., A.R.T.C.S.
SMITH, Clifford
SUMNER, Alan Martin
TAYLOR, John Arthur Gordon
WILKINSON, Allan

Chelmsford, Mid-Essex Technical College.—The Liaison Officer at the Mid-Essex Technical College from September will be Dr T. Green, *Associate*, lecturer in chemistry, in succession to Mr F. W. F. Hendry, who has retired.

Bristol College of Technology.—The Bristol College of Technology became a college of advanced technology on 1 September. Work up to and including O.N.C. will in future be carried out in the Bristol Technical College, which will act as a feeder college to the College of Technology.

Lanchester College of Technology, Coventry.—As from September, all post-O.N.C. work at Coventry Technical College will be transferred to the newly-established Lanchester College of Technology. Recognition by the Institute for the training of candidates for the Graduate Membership examination has been formally transferred to the new college. The Lanchester College will offer advanced courses in science, technology, management and business studies for those students who have completed their preliminary training at Coventry Technical College or elsewhere. The Principal of the College is Dr A. J. Richmond, who was Principal of the Coventry Technical College. The head of the department of chemistry, metallurgy and textiles is Dr M. E. Foss, *Fellow*, who is also Vice-Principal of the College. The new Principal of the Coventry Technical College is Dr H. C. Smith, *Fellow*.

The Council recently nominated Professor J. C. Robb, *Fellow*, as the first Institute representative on the Governing Body of the Lanchester College of Technology. Mr D. Entwistle, *Fellow*, is the Institute representative on the Applied Science Advisory Committee, of which he is the Chairman this session.

SPECIAL INSTITUTE LECTURES

Presentation of Meldola Medals for 1959 and Lectures by the Medallists.—At a meeting to be held at the Royal Institution, 21 Albemarle Street, London, W.1, on Wednesday, 9 November at 5.45 p.m., the President of the Institute will present Meldola Medals for 1959 to Dr J. I. G. CADOGAN and Dr T. C. WADDINGTON (*see J.*, 179–180), and this ceremony will be followed immediately by the Meldola Medal Lecture by Dr Waddington, entitled 'Liquid Hydrogen Halides as Ionizing Solvents.' Visitors will be welcome.

By invitation of the Manchester University Chemical Society, Dr Cadogan will deliver his Meldola Medal Lecture entitled 'Recent Developments in Free Radical Addition Reactions' in the Large Chemistry Theatre, University of Manchester, in the previous week—on Tuesday, 1 November, at 4 p.m.

Dalton Lecture.—The Eleventh Dalton Lecture, entitled 'Chemistry in Everyday Life—the Contribution of the Department of Scientific and Industrial Research,' will be given by Sir Harry Melville, K.C.B., F.R.S., on 28 October at 7 p.m. in the Manchester Town Hall (by kind permission of the Lord Mayor and Corporation of the City of Manchester). The Chairman is Mr E. Le Q. Herbert, *President*, and the Principal Guest will be the Lord Mayor of Manchester, Alderman Arthur Donovan, J.P. Admission is by ticket only, obtainable from the Hon. Secretary of the Manchester and District Section, Mr R. Shackleton, Magnesium Elektron Ltd, P.O. Box No. 6, Lumm's Lane, Clifton Junction, Swinton, Manchester.

Humphry Davy Lecture.—Professor V. N. Kondratiev, Member of the U.S.S.R. Academy of Sciences,

has agreed to give the Second Humphry Davy Lecture at the Royal Institution, 21 Albemarle Street, London, W.1, on Wednesday, 12 October at 7 p.m. The title of the address will be 'Energy Exchange in the Interaction of Particles under Electric Discharge.' Light refreshments will be available from 6.30 to 7 p.m.

Among Professor Kondratives' notable contributions may be mentioned the mass-spectroscopic investigation of molecular ionization under electric impact, studies of photochemical dissociation and pre-dissociation of molecules, and of the mechanism of photochemical reactions, determination of atom and radical concentrations under electric discharge and in flames, recombination of atoms and radicals, and investigations of chemiluminiscence of flames.

He has written several books: *Electron Chemistry* (in conjunction with N. N. Semenov and Yu. B. Khariton; 1927), *Physical and Chemical Properties of Molecules* (1928), *Photochemistry* (1933), *Elementary Processes of Energy Exchange in Gases* (in conjunction with M. A. Elyashevich; 1933), *Structure of Atoms and Molecules* (1934, 1946, 1960), *Elementary Chemical Processes* (1936), *Free Hydroxyl* (1939), *Spectroscopic Investigations on Chemical Gas Reactions* (1944) and *Kinetics of Chemical Gas Reactions* (1958).

MELDOLA AWARD FOR 1960

The **Meldola Medal** is the gift of the Society of Maccabaeans and is normally awarded annually. The next award will be made early in 1961 to the chemist who, being a British subject and **under 30 years of age at 31 December, 1960,** shows the most promise as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before 31 December, 1960.

No restrictions are placed upon the kind of chemical work or the place in which it is conducted. The merits of the work may be brought to the notice of the Council, either by persons who desire to recommend the candidate or by the candidate himself, by letter addressed to **The President, The Royal Institute of Chemistry,** 30 Russell Square, London, W.C.1, the envelope being marked 'Meldola Medal.'

The letter should be accompanied by **six copies** of a short statement on the candidate's career (date of birth, education and experience, degrees and other qualifications, special awards, etc., with dates) and of a list of titles, with references, of papers or other works published by the candidate, independently or jointly. Candidates are also advised to forward one reprint of each published paper of which copies are available.

BEILBY MEDAL AND PRIZE 1961

Since 1930, at intervals of one or more years, awards have been made by the Administrators of the Sir George Beilby Memorial Fund, representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals. Sir George Beilby had been President of each of these three bodies, and they jointly sponsored the appeal for subscriptions whereby the Fund was raised as a memorial to him after his death in 1925.

The awards are made to British investigators in science in recognition of independent original work of exceptional merit, carried out continuously over a period of years and involving the development and application of scientific principles in any field related to the special interests of Sir George Beilby, that is in chemical engineering, fuel technology or metallurgy, in their modern interpretations. The awards are intended as an encouragement to younger men and women (preferably under the age of 40) who have done distinguished work of practical significance in any of these fields.

In 1958 two awards, each of 150 guineas, were made. It was then agreed that no further award would be made before 1960 (*see J.*, 1958, 331).

The Administrators have decided that henceforth each award shall consist of a gold medal as well as a substantial sum of money, and shall be known as 'The Beilby Medal and Prize' and specified as being 'For Advancement in Science and Practice.' Such an award will be offered at intervals of two years, but more than one may be made on the same occasion if there are several candidates of sufficiently outstanding merit.

Consideration will be given in due course to the making of an award (or awards) from the Fund in 1961. Outstanding work of the nature indicated may be brought to the notice of the Administrators, either by persons who desire to recommend the candidate or by the candidate himself, not later than **31 December, 1960,** by letter addressed to **The Convener of the Administrators, Sir George Beilby Memorial Fund,** The Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

The letter should be accompanied by **nine copies** of a short statement on the candidate's career (date of birth, education and experience, degrees and other qualifications, special awards, etc., with dates) and of a list of titles, with references, of papers or other works published by the candidate, independently or jointly. Photographic copies of these documents are acceptable. Candidates are also advised to forward one reprint of each published paper of which copies are available.

Lectures, Monographs and Reports, 1960.—Two new monographs in the series have recently been distributed.

No. 1. *Recent Studies in Boron Chemistry*, by Dr H. G. Heal (5*s.*)

In this specially contributed item, Dr Heal has not attempted to deal with all recent developments in this very active field of chemical research. He has chosen

instead to give 'a full account of a limited number of topics, selecting mainly those which have not been adequately covered in other recent reviews.' These are complex halogen acids of boron, the subhalides of boron, the boron hydrides, the boranates, triaryl boron anions and similar alkyl boron anions and boronium salts.

Much detailed information about boranates and substituted boranates is given in tabular form and there are 257 references, mainly to recent published work.

No. 2. *Use of Non-Aqueous Solvents in Inorganic Chemistry*, by Dr C. C. Addison (4*s.* 6*d.*)

This monograph is based on Dr Addison's lecture to the London Section held on 27 January at the Slough College of Further Education. In his introduction, the author reminds us that non-aqueous inorganic solvents have been in use since the beginning of the century. Though it may be an overstatement to say the availability of water has actually restricted the development of inorganic chemistry there is no doubt that it has diverted its study along channels that were not always the most ideal or efficient. He deals with the subject under the following headings : variation in experimental conditions; factors influencing choice of solvent; solutions of metals; use of mixtures of non-aqueous solvents; anhydrous copper nitrate; solvates; and molten salts.

Register of Fellows and Associates, 1960.—A new edition of the *Register* is about to be prepared and will contain the names, qualifications, addresses and occupations of all who are Fellows, Associates or Graduate Members of the Institute on 31 October, 1960.

Cards on which to enter particulars are being sent under separate cover to members overseas during this month. These members are asked to fill in the card and return it to the Institute immediately, preferably by air-mail.

Fellows, Associates and Graduate Members in Great Britain and Ireland will receive their card next month (October).

The importance of an up-to-date and accurate *Register* can scarcely be over-emphasized. To avoid delays in publication and subsequent correspondence resulting from incorrect entries, **members are asked to co-operate by filling in their cards carefully and legibly and by returning them forthwith.**

It is regretted that it is necessary to ask every member to furnish all the required particulars even if no changes have occurred in the last two years, but if this were not done errors would be likely to arise or be perpetuated especially for members who have not available a copy of the previous edition of the *Register* for comparison. If any member does not return a card his entry will not include letters denoting corporate membership of qualifying professional bodies other than the R.I.C. or any reference to occupation or telephone number, and the *registered* address will be given.

The Council reserves the right to decide which designatory letters representing qualifications shall be accepted for inclusion in the *Register* and to authorize the amendment or exclusion of other particulars that are not stated in the form required.

As these cards will be used only for the compilation of the printed *Register*, members are requested to communicate separately any changes for record purposes.

Directory of Independent Consultants.—Arrangements are being made to collect information for a new edition of the Institute's *Directory of Independent Consultants in Chemistry and Related Subjects*. Subject to the settlement of matters of detail, it is expected that the relevant forms will be available by the end of October for issue to Fellows and Associates who are known to be Principals of independent consulting practices in the U.K. Any Fellow or Associate who is responsible for a practice, which seems to be eligible for inclusion in the Directory but was *not* recorded in the 1955 edition, is asked to **notify the Secretary of the Institute** so as to ensure that particulars of the new edition, and the appropriate forms, are duly sent to him.

PERSONAL NOTES

Honours and Awards

Professor G. Gee, C.B.E., F.R.S., *Fellow*, has been awarded the Swinburne Medal by the Council of the Plastics Institute for his outstanding contributions to the advancement of polymer chemistry. This is the first award of the Medal, which commemorates Sir James Swinburne, F.R.S., who died in 1958.

Dr J. C. McGowan, *Fellow*, has been awarded the degree of Doctor of Science by the University of London.

Professor R. G. W. Norrish, F.R.S., *Fellow*, has been elected an honorary member of the Akademie der Wissenschaften zu Göttingen and of the Société Royale des Sciences de Liége.

Societies and Associations

Mr G. A. Campbell, *Fellow*, of the Geigy Co. Ltd, has been elected vice-president of the Industrial Pest Control Association for the year 1960–61.

Sir Charles Goodeve, O.B.E., F.R.S., *Fellow*, is to be nominated President-elect of the Iron and Steel Institute at its meeting in November.

Dr W. J. S. Naunton, *Fellow*, has been elected a life vice-president of the Institution of the Rubber Industry.

Mr S. D. Sutton, *Fellow*, has been elected a vice-president of the Federation of British Rubber and Allied Manufacturers for 1960–61.

Mr J. W. Turton, *Associate*, has been elected President of the Association of Teachers in Technical Institutions

for the year 1960–61. His presidential address was delivered at the 51st Annual Conference of the A.T.T.I. in Folkestone on 5 June.

Mr E. E. White, *Fellow*, has been appointed head of the British Iron and Steel Research Association corrosion advice bureau. He is technical secretary to the Association.

Educational

Dr A. E. Canavan, *Associate*, has been awarded the first Ph.D. degree in chemistry of the University of Leicester.

Dr A. F. Casey, *Fellow*, has been promoted to a principal lectureship at the School of Pharmacy, Chelsea College of Science and Technology.

Professor E. J. Conway, F.R.S., *Fellow*, Professor of Biochemistry and Pharmacology, University College, Dublin, has been appointed Chairman of the Dublin Institute for Advanced Studies for the period ending 30 June, 1965.

Sir Alexander Fleck, K.B.E., F.R.S., *Fellow*, is to give the seventh Fawley Foundation lecture at the University of Southampton on 10 November. The title of his address will be 'Science and industry; a blend with the humanities.'

Dr W. J. Hickinbottom, *Fellow*, has had the title of Professor of Organic Chemistry in the University of London conferred on him in respect of his post at Queen Mary College.

Mr D. W. Hutchinson, *Associate*, is leaving England at the end of the month to take up a postdoctoral fellowship at Massachusetts Institute of Technology.

Mr J. L. Jardine, *Associate*, has left Bourne School, HQ Kuala Lumpur Garrison, Malaya, to take up the post of chemistry master at Paisley Grammar School.

Mr J. B. Kearns, *Associate*, has left this country to take up a graduate assistantship in the department of biochemistry and nutrition of Cornell University, N.Y.

Mr O. Owen, *Associate*, has resigned his position as head of the chemistry department, Pwllheli Grammar School, to take up an appointment as lecturer in science, Normal College, Bangor.

Mr H. Price, *Fellow*, has been elected Professor of Pharmacy at Rhodes University, Grahamstown, South Africa. Formerly senior lecturer in pharmacy and head of department, he will be the first holder of the chair.

Dr F. Rumford, *Fellow*, principal lecturer in the department of chemical technology, The Royal College of Science and Technology, Glasgow, has been appointed Professor of Chemical Engineering in the new Delhi College of Technology.

Dr D. C. Smith, *Associate*, is to be visiting Associate Professor in dental materials at Northwestern University, Chicago, for the academic year 1960–61. Dr Smith is lecturer in dental materials University of Manchester.

Mr G. M. Timmis, *Fellow*, has been appointed reader in chemistry, University of London, in respect of his post at the Institute of Cancer Research, Royal Cancer Hospital.

Dr B. L. Tonge, *Associate*, has relinquished his post as research chemist with the General Electric Co. Ltd, Wembley, to become a lecturer in chemistry at the Plymouth and Devonport Technical College.

Professor E. E. Turner, F.R.S., *Fellow*, has been appointed Professor Emeritus of Chemistry, University of London, on his retirement from the Chair of Chemistry at Bedford College.

Dr A. P. Wade, *Associate*, formerly a biochemist with the Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, has taken up the post of lecturer in endocrine biochemistry in the University Endocrine Unit, the Radium Institute, Liverpool.

Dr E. O'F. Walsh, *Fellow*, reader in biochemistry in the University of London at the Royal Free Hospital School of Medicine, has been appointed to the new Chair of Biochemistry in the University of Hong Kong, and will be sailing in October.

National Council for Technological Awards.—The following *Fellows* are assisting in the work of the Council:—Governing Body: Dr J. W. Cook, F.R.S., Dr E. G. Edwards, Dr W. I. Jones, C.B.E., Mr G. Loasby, Dr P. F. R. Venables; Board of Studies in Engineering: Dr F. Briers, Mr A. S. White; Board of Studies in Technologies other than Engineering: Mr G. Loasby, Chairman, Dr J. W. Cook, F.R.S., Dr J. E. Garside, Dr J. E. Salmon, Dr G. Tolley, Dr A. M. Ward, Dr G. E. Watts, Dr C. Whitworth, Dr V. E. Yarsley; Co-opted Members of Subject Panels: Professor W. Bradley, Dr F. H. Cotton, Dr H. Davis, C.B.E., Mr T. C. Denston, Dr R. L. Elliott, Dr F. Hartley, Professor F. Morton, Dr A. R. Urquhart; Board of Scientific and Industrial Studies of the College of Technologists: Dr J. W. Cook, F.R.S., Dr J. E. Salmon; Industrial Training Panel, Mr G. Loasby, Dr C. Whitworth.

Consultant

Mr A. J. Prince, *Fellow*, formerly development director, heavy organic chemicals division, I.C.I. Ltd, Billingham, is now operating a consulting practice from La Lezardière, Cinq Mars La Pile, Indre-et-Loire, France, with special reference to fertilizers, heavy chemicals and petroleum chemicals.

Public and Industrial

Mr D. A. Adeyemo, *Associate*, formerly of the research department, Associated Portland Cement Manufacturers Ltd, has taken up an appointment with the West African Portland Cement Co., Ikeja, Nigeria.

Dr V. A. Atkinson, *Associate*, has been appointed a science officer with the British Council. He was formerly Norges Teknisk-Naturvitenskapelige Forskningsråd Research Fellow at the University of Oslo.

Mr W. J. Bayley, *Fellow*, chief chemist, Capper Pass & Son Ltd, will shortly be moving to the Bristol works of his company. He is at present at the Melton works.

Dr C. M. Bean, *Fellow*, has been awarded a personal appointment to senior staff at the deputy chief scientist level by the United Kingdom Atomic Energy Authority.

Mr C. W. Cater, *Associate*, has resigned his post with Imperial Chemical Industries Ltd to take up an appointment as research chemist with the British Leather Manufacturers' Research Association, Egham.

Mr J. C. Cragg, *Fellow*, has been appointed a member of the reconstituted board of directors of Metal Cleaning Ltd, a member of the Castrol group of companies.

Mr G. Davidson, *Fellow*, has retired from his position as Vice-President (Manufacturing), Shell Oil Co. of Canada Ltd, Toronto. He has accepted an assignment with the International Labour Office in Central America, and will shortly be taking up residence in San Salvador, Guatemala.

Dr W. E. Elstow, *Fellow*, has been appointed in succession to Mr F. A. Lyne as deputy public analyst for Fulham, Mr T. McLachlan, D.C.M., remaining Public Analyst.

Dr C. Forrester, K-i-H., *Fellow*, has retired from the Ministry of Power, and taken up an appointment as liaison and publications officer of the British Coal Utilisation Research Association, Leatherhead.

Mr A. Gordon, *Associate*, has left the Pyrene Co. Ltd, Brentford, to take up a post as food technologist with the British Food Manufacturing Industries Research Association at Leatherhead.

Mr J. B. Horn, *Associate*, has resigned his position as laboratories manager of the India Tyre & Rubber Co. Ltd to take up an appointment as assistant technical manager of Cabot Carbon Ltd, Stanlow, Ellesmere Port, Cheshire.

Mr H. W. Jones, *Fellow*, has been appointed group manufacturing manager with the Aspro-Nicholas group of companies, Slough. He was formerly chief chemical engineer with John Wyeth & Brother Ltd, Havant.

Dr H. Kaiwar, *Associate*, has been appointed head of the laboratory department, Atic Industries Ltd, P.O. Atul, Via Bulsar, Dist. Surat, India.

Dr G. S. Learmonth, *Fellow*, has left the service of Turner Bros Asbestos Co. Ltd to take up an appointment as manager (synthetic resins) with the research and development department of Formica Ltd at West Chirton, Northumberland.

Mr J. R. McShane, *Associate*, has taken up an appointment as development chemist with John & E. Sturge Ltd, Selby, Yorkshire. He was formerly employed as a chemist by the Esso Petroleum Co. Ltd.

Mr D. J. Munns, *Associate*, has been appointed to the board of H.P. Sauce Ltd.

Mr D. A. Phillips, *Associate*, has taken up an appointment as chief chemist of Altona Petrochemicals Co. Pty Ltd, Australia.

Lt-Col F. M. Potter, O.B.E., T.D., D.L., *Fellow*, has been elected president of the Forth Valley Chamber of Commerce. He has also been elected to the General Council of the British Standards Institution, and is chairman of the Wood Preservation Divisional Committee.

Mr N. P. Rao, *Associate*, has been promoted to senior scientific officer, Grade I, in the Defence Science Service, and appointed editor, Research and Development Publications, c/o Defence Science Laboratory, Metcalfe House, Delhi 8, India.

Dr G. D. Rosen, *Fellow*, has been appointed general manager of International Protein Products Ltd, a subsidiary of British Glues & Chemicals Ltd formed to develop the manufacture and sale on a world-wide basis of protein isolates produced from vegetable sources by the Chayen process.

Mr R. R. Sandie, *Graduate Member*, has relinquished his post of research assistant in the biochemistry department of the Heriot-Watt College, Edinburgh, to take up an appointment as research chemist with the Fruit and Vegetable Canning and Quick Freezing Research Association.

Dr M. A. Smith, *Associate*, has taken up an appointment as research chemist with Whiffen & Sons Ltd.

Dr R. Spence, C.B., *Fellow*, chief chemist and head of the chemical division, Atomic Energy Research Establishment, Harwell, has been appointed deputy director.

Mr W. T. Spragg, *Fellow*, has resigned his post at the Institute of Nuclear Science, Teheran, Iran, and has returned to this country on leave before taking up another appointment overseas.

Retirements

Mr A. A. Eldridge, *Fellow*, assistant director of the chemical laboratories at Imperial College of Science and Technology, is to retire on 30 September. On graduating from King's College, London, in 1910, Mr Eldridge went to the Imperial College which he has since served continuously for 50 years. On 28 July a presentation was made to him in the Chemistry Department to mark the esteem and very real affection in which he is held by past and present students and staff of the College. This presentation, which included a book of signatures of those who had been his colleagues or had passed through his hands in the past half century, was made by Professor Barrer in the presence of the Rector, Sir Patrick Linstead, and a large and representative gathering of those who had assembled to express their gratitude to Mr Eldridge and their good wishes to him and Mrs Eldridge in his retirement.

NEW TELEPHONE NUMBER

As from 15 September the Telephone Number of the Institute will be LANGHAM 3482.

Section Activities

BRISTOL AND DISTRICT

Summary of Events, 1960

Professor R. L. Wain, F.R.S., gave the Christmas Lecture, 'Plant Growth Hormones', in the morning and afternoon of 6 January, before a total audience of 700 sixth formers. In proposing a vote of thanks to Professor Wain, the Chairman, Dr D. Woodcock, expressed the unanimous view of those present in describing this excursion into the field of biology as an unqualified success.

Dr J. N. Andrews gave a detailed survey of radiochemical analysis at the College of Technology, Bristol, on 8 January, on the occasion of a joint meeting with the South Western Section of the Society for Analytical Chemistry. The Chair was taken by Mr R. C. Chirnside, President of the Society.

On 14 January Mr J. G. Graham of Imperial Chemical Industries Ltd, Dyestuffs Division, spoke on the dyeing of the newer synthetic fibres at the University of Bristol. He discussed the problems raised for the dyestuffs chemist by the development of nylon, Terylene, Acrilan, and so on. Not the least surprising piece of information was that diazotization was carried out at temperatures as high as 100°C.

Dr F. L. Rose, O.B.E., F.R.S., lectured on chemotherapeutic research at the Gloucester Technical College on 18 February. He presented the subject with humour, at the same time conveying to his audience the need for vast patience and care in this work before any substance could be regarded as acceptable in the medical field.

X-ray fluorescence analysis has developed greatly in recent years, and Mr J. R. Stansfield, of Hilger and Watts Ltd, gave a very sound critical survey of the technique in relation to other methods of analysis in his lecture given at the University of Bristol on 17 March.

Summer Visits

Bristol Waterworks and the Ubley Trout Hatcheries. An evening visit was arranged by Mr F. P. Hornby, chief chemist of the Bristol Waterworks Company on 5 May. The highlight was undoubtedly the visit to the Trout Hatcheries, where the enthusiasm of the wardens was clearly shown in their account of the work. At the end of an evening of real exploration by car of this corner of Somerset, members and their wives adjourned to one of the pumping stations for coffee and sandwiches, when Dr Woodcock, Section Chairman, paid tribute to Mr Hornby's efforts to ensure the success of the evening.

The Royal Forest Factory, Coleford. A party of members and wives travelled by coach to the edge of the Forest of Dean on 2 June, where they were met by Dr V. L. S. Charley. Dr Charley, who was born in the area, acted as guide in the Forest and his intimate knowledge of the area and his skill in using the microphone would have put many a professional guide to shame.

Lunch at Speech House was followed by a visit to the 'Carters' Factory at Coleford, where tea was provided by the management after a most interesting tour of the factory.

In his vote of thanks to Dr Charley and the production staff, Dr D. Woodcock described the visit as memorable, and possibly unique, in that the party had been shown round a factory which was largely of their guide's own conception.

EAST ANGLIA

Visit to Shell Haven. Members, their ladies and friends were entertained at Shell Haven on 1 July. The party arrived at noon, and the history and layout of the site were explained by Mr Ian Black and his colleagues.

After lunch the party was divided into four groups to tour the laboratories and distillation units. As each party took a slightly different route, the visitors were able to get a more detailed picture of all the interesting things to be seen in the short time available by comparing notes afterwards.

Over tea the Section Chairman, Dr E. C. Wood, expressed the gratitude of the Section to the staff at Shell Haven whose assistance had contributed so much towards the success of the visit.

LONDON

Visit to Fords. A party visited the Ford Works at Dagenham on 9 June.

After a brief tour of the general control laboratories, which deal mainly with steels, refractories and paints, the party was taken over the foundry. There they saw 15-ton electric-arc furnaces in operation, and blast-furnace charges being emptied. The steel made here is used for crankshafts, differentials and so on. They then visited the 48 coke-oven battery, which uses Durham coal to produce 4,000,000 cu. ft of gas per day.

The sections where the car bodies were made and the cars assembled were the most impressive. The body parts are pressed from mild steel by one or more of 250 presses working at a pressure of 1,000–1,400 tons/sq. in. The bodies are assembled mainly by automatic welders, and then travel by overhead railway to the paint, trim and assembly shop where the cars undergo a number of searching tests before being driven off the assembly line ready for delivery to their final destinations.

Follow-the-Trail Car Rally. This new summer venture by the Social Activities Sub-Committee took place on 11 June, and proved to be one of the most popular and enjoyable functions so far held. The small group of organizers consisted of Dr R. A. Jeffreys and Messrs P. F. Corbett, H. W. Hodgson and A. J. Turnbull who were assisted on the day by Messrs H. Murray and Ivan Corbett.

All the arrangements went smoothly and 60 cars containing 200 people made their way either from Stanmore or Hampton Court to Iver Heath and thence via lanes and by-ways through the beautiful country around Burnham Beeches, ending the trail at Bourne End. Here most of the party had tea on the extensive lawns of the Spade Oak Hotel, which was the final check point. A small number picnicked on the banks of the nearby Thames.

Entrants answered questions on the Highway Code, collected named specimens of wild flowers, identified photographs of places *en route* and solved clues of the crossword-puzzle type which led them to their final destination. Only a few had need to open the sealed instructions for getting to the finishing point. Many members scored well over 80 of the possible 100 points, but the best four entrants were Dr N. Booth (94), Mr P. A. Raine (93), Mr W. G. Peterson and Dr L. O. Butler (both 92). Mr A. J. Turnbull, Vice-Chairman, presented Dr Booth with an engraved plaque and the other members with small prizes.

The younger passengers took part in a separate junior competition, again answering questions on the Highway Code and collecting specimens and also seeing how many words they could make from the letters in the word 'chemistry.' The winners here were Misses Dorothy Pye and Carol Salmon, who scored 81 words in the last-mentioned section of the competition; all the competitors received small prizes.

There was great demand for a further outing of this kind, and another is being arranged in the Essex area and will take place on 21 September.

The Times Publishing Co. Ltd. On the evening of 13 June a small party of members once more saw the first edition of *The Times* go to press. The party was welcomed by Mr Park, night production manager, and conducted round the building in two groups by Messrs Brock and Paxton. After visiting the teleprinter room, members proceeded to the library and reference room, where they were able to inspect several historic copies of *The Times* on a microfilm projector. In the composing room setting up of type by hand and by the Monotype and Linotype processes was demonstrated. Visitors were provided with personal name dies cast by the Linotype machine. The making up of corrected pages into the 'forme,' the production of the semi-circular papier maché 'flong' by pressure and the casting of the stereotype plate were then seen. Finally the plates were locked on the rotary presses supplied with newsprint from the basement floor. A considerable number of copies of the paper are dispatched each evening to private subscribers, and there is also an air-mail edition.

Refreshments were kindly provided in the Board Room and Mr A. J. Turnbull thanked the management for a most interesting evening and for their continued hospitality.

R.H.S. Gardens, Wisley. Members and their guests had the benefit of a sunny afternoon for their visit to the Royal Horticultural Society's Gardens at Wisley on 18 June. In view of the connection between horticulture and chemistry, it was fitting that several members of the party proved to be Fellows of the Society as well. The party was split into two groups, and two guides conducted them over the gardens by separate routes. The arrangements were fortunately most informal, and so members were able to see those sections of the gardens in which they were particularly interested. A complete tour was not possible in the time available as there was so much to see and enjoy. The guides provided a wealth of information about the Gardens, and they very kindly answered a range of questions on general gardening practice. By a strange coincidence, each of the parties finished its tour at the restaurant. The visitors' gratitude was expressed to the guides, who undertook to convey the thanks of the party to the Society's officers.

Firestone Tyre & Rubber Co. Ltd. Members were the guests of the Firestone Tyre & Rubber Co. Ltd, Great West Road, Brentford, on 21 June, when they toured the factory and the complex operations involved in the manufacture of the modern motor-car tyre were explained to them.

The party, led by Mr R. J. Cole, a member of the Section Committee, was received by Mr H. R. Stewart, Firestone's public relations officer, and were introduced to Mr Mernagh, the chief chemist, and members of his staff who subsequently acted as guides. Mr Mernagh outlined the background of the company, which originated in America in 1900 and is now a world-wide organization.

The company makes all kinds of motor vehicle tyres, from motor scooter tyres to the extremely large tyres used for earth-moving equipment, costing about £1,000 each. Recent developments are go-cart tyres and wire tyres. Both natural and synthetic rubbers are used.

The factory is highly mechanized, special features being the complexity of much of the equipment, conveying of heavy parts, high-temperature working, the use of butyl rubber as 'balloons' in the modern curing technique, use of radioactive thickness gauges, and so on.

Following American trends, particular attention is paid to white-wall tyres, weight balancing (for which special testing equipment was examined with interest) and quiet running performance of motor car tyres on cornering, for example, as well as basic mechanical design, strength flexibility and rolling friction.

The party was then entertained to tea in the canteen, when there was an opportunity for further discussion. Mr Cole thanked the hosts on behalf of the Section for a most interesting visit. In reply, Mr Mernagh said how pleased the company had been to entertain the Section; this had been the first visit but he hoped it would be repeated.

I.C.I. Ltd (*Plastics Division*). On 29 June a party of members travelled to Welwyn Garden City, where they were welcomed by Mr R. D. Bacon, of the technical service and development laboratories. As in previous years, a tour of the technical service section was followed by visits to the exhibition room and the research laboratories. On this occasion the visitors were able to see a demonstration of electron-spin resonance techniques in the study of free radicals. During tea Mr A. J. Turnbull thanked the staff concerned for their contribution to an instructive and enjoyable visit.

Parke Davis & Co. Ltd. A party of members were cordially received by Mr H. A. D. Murray, the house manager, on 5 July. They were then divided into small groups and conducted round the factory by members of the scientific staff. Among the interesting units which were explained to them were the chloromycetin manufacturing plants, where several stages of the synthesis were carried out in Pfaudler vessels. They were also shown the tincture manufacture, the dry capsule filling plant, the microbiological enzyme manufacturing plant and the pharmaceutical compounding plants, where such varied items as cough syrup and tooth paste were formulated.

The ancillary units of the analytical department (including gas chromatography analysis), pharmacology department (where routine testing is done as well as research) and chemical research department were all visited, and the work done there was discussed and explained in some detail.

Finally, the party was entertained to tea, and each visitor was given a gift of the company's products. A speech of thanks to the directors was made by Dr C. Simons.

Burroughs Wellcome & Co. On 6 July, a party was entertained by Messrs Burroughs Wellcome & Co. at their Dartford Works. The visit began with a film showing the history of the Wellcome Foundation and its founder. A visit to the 'Tabloid' manufacturing department followed, where the methods of making these products were explained and demonstrated. A lecture by Dr Dewing on the work of the development department concluded the morning's activities and was followed by lunch at the Social Club.

After lunch the visitors toured the biological assay laboratories, where the assays of drugs which cannot be estimated by chemical means were seen. Visits were then paid to various sections of the chemical manufacturing division, including synthetics, alkaloids and insulin, the latter being particularly interesting because of the care needed in extracting an unstable material present in very small quantities.

In the pharmaceutical division the solutions, automatic ampoule filling, sterilizing and packaging operations were seen, together with the packaging of 'Tabloid' products. Finally visits were made to the development laboratories, and the visit concluded with tea.

Mr R. H. A. Cooper proposed a vote of thanks to the company. He particularly thanked the guides and

the various members of the staff who had explained the operations and made the tour so interesting.

New Grade of Membership

Special General Meeting. On 13 July, a Special General Meeting was held in Shell Mex House to discuss the Council's statement on a possible new grade of membership and category of affiliation. About 80 members were present, and the Chair was taken by Mr F. C. Hymas, who was supported by the Officers of the Section. Dr H. J. T. Ellingham attended by invitation of the Chairman in order to hear the views expressed, and he gave valuable assistance to the meeting by giving background information on many of the points raised.

The Chairman opened the proceedings by referring briefly to the proposals outlined in the April Journal of the Institute (*J.*, 122), reminding members of the two main suggestions, *i.e.* one for Licentiateship as a new grade of membership, and the other for the formation of a Registered Chemical Assistants Group, affiliated to the Institute. These proposals have deliberately been presented many months before any decision on them is likely to be taken in order that members should be given ample time for consideration and discussion. This meeting had been called to provide such an opportunity for discussion without any formal resolutions, for the Section Committee felt that such resolutions might not be particularly helpful at this stage.

A vigorous discussion then ensued, in the course of which about 25 members expressed their views. There was no doubt that the majority of these speakers were in favour of the proposal for Licentiateship, albeit with reservations in many instances. However, there was very little support for the suggested formation of a body of Registered Chemical Assistants. Only three speakers were opposed to both proposals. All speakers were agreed that any extension of membership must be arranged in a manner that could not possibly lead to

lowering the status of the Institute's existing qualifications; much of the discussion was quite naturally devoted to points of detail on the levels of attainment that the various qualifications might be considered to represent. Most speakers recognized that there were many chemists who for quite good reasons would not reach the Institute's Graduate Membership level, but who were nevertheless valuable members of the profession, and should therefore be brought within the orbit of Institute activities. Several speakers took the view that the introduction of a properly controlled third permanent grade of membership, so far from lowering the standards of existing Institute qualifications, would actually enhance their status. Support for the Licentiateship proposal was forthcoming from several members particularly concerned with the problems of part-time education in technical colleges; they regarded it as an attempt to cater for the needs of those with a satisfactory standard of general education who reached a good H.N.C. level or passed Part I of the Grad. R.I.C. examination but might never qualify in Part II. As such, they welcomed the proposal for Licentiateship and considered that nothing but good could result.

In a meeting of this character, as might be expected, many widely differing views were expressed on the relative merits of University qualifications, those of the Institute, the comparatively new Dip. Tech. and the H.N.C. Perhaps the greatest misgiving was on the standard of general education of candidates for H.N.C., it being recognized that in this respect the minimum standards required were considerably below those of the Universities and the Institute. For this reason the majority of speakers were opposed to the setting up of any grade which would automatically admit holders of H.N.C. to membership of the Institute.

There was considerable discussion on the status of the proposed Licentiates within the framework of the Institute itself, and on the definition of the term 'Corporate Members.' Opinions were very divided on this point, some members feeling it was of little importance whilst others deplored any suggestion that voting rights should be indefinitely withheld from a potentially numerous class of Institute members. It was pointed out that the Council was preserving an open mind on this matter, and wished only to act in a manner that would serve the best interests of the profession and, in particular, of Institute members.

The members present concluded that there had been a very free expression of views, which it was hoped would be of some benefit to the Council in its deliberations, but that there was no point in presenting any formal resolution from this meeting. Finally, Mr Hymas assured those present that a précis of the individual comments would be available to the Council in due course, and he thanked the authorities at Shell Mex House for making it possible to hold the meeting in such comfortable surroundings.

Popular Lecture

The Section is embarking on a new venture, starting in the 1960–61 lecture season. A series of popular lectures on subjects to which chemists have made important contributions is being arranged. The lectures are intended for intelligent adult audiences with no special scientific knowledge, but they should also be of interest to students and trained chemists.

Lectures so far arranged include 'Modern Colour Photographic Processes' by Mr R. B. Collins at the Goldsmiths' College on 26 October at 7 p.m., and 'Detergents' by Dr K. G. A. Pankhurst at Hendon Technical College on 29 March, 1961, at 7.30 p.m.

MANCHESTER AND DISTRICT

East Lancashire Paper Mill Co. Ltd. On the afternoon of 22 June members visited the Radcliffe Works of the East Lancashire Paper Mill Co. Ltd. They were welcomed by the chief chemist, Mr J. Bentley, and then taken on a tour of the mill. All stages of the manufacture of high-quality notepaper from pulp were explained by the guides, and the visitors were particularly impressed by the efficiency of the water purification plant and the inspection of the finished product.

After tea, kindly provided by the company, Dr A. F. Daglish thanked the directors and staff for their hospitality.

Gilbert & John Greenall Ltd. On 29 June, a party visited the gin distillery of Gilbert & John Greenall Ltd at Warrington. Warrington Gin has been produced on this site since 1761, and the process has changed little over the years. Juniper seeds and angelica from Germany, coriander seeds from Morocco, powdered orris root from Italy, dried lemon peel from Spain, bitter almond powder from the Near East, nutmeg powder and powdered liquorice root were extracted by alcohol vapour and the resulting condensate was sampled by the visitors during manufacture, and finally the end product was tasted and approved.

The managing director, Mr Greenall, was thanked for making the excellent arrangements for the visit.

Carpet Trades Ltd. Members and their wives enjoyed a whole-day visit to Carpet Trades Ltd, Kidderminster, on 6 July. After lunch near Bewdley, the visitors were welcomed by Mr George Robinson, chief chemist of the company, and shown a film outlining the work of the factory. The party then toured the laboratories, wool preparation and dyeing plant, and carpet manufacture section. The visitors were particularly interested in the working of the various types of carpet-making machinery and the differences between Axminster and Wilton carpets.

After the visit, the party was entertained to tea, and Dr L. R. Ridgway, Section Chairman, thanked the company and staff for a very enjoyable visit.

DECCAN

Works Visit. On 11 June a party of members and guests visited the Amco Batteries (Private) Ltd, Mysore Road, Bangalore, where they spent an interesting and useful afternoon.

Mr K. G. Parameswaran, the managing director of the firm, welcomed the party and gave an interesting talk on the history and development of the organization, including the present position of the industry in India. The chief chemist and other members of the staff then took the party round the laboratory, and showed the manufacturing processes in the different departments of the factory. Finally coffee was served in the canteen. Dr S. C. Pillai expressed the thanks of the Section to Mr Parameswaran and his staff for their hospitality and detailed explanations.

Vitamins A_1 and A_2. At a joint meeting with the Mysore State Branch of the Indian Pharmaceutical Association held in the General Chemistry Lecture Hall of the Indian Institute of Science, Bangalore, on 4 August, Dr Homi R. Cama, Assistant Professor of Biochemistry at the Indian Institute of Science, lectured on 'Vitamins A_1 and A_2.' Dr B. N. Acharya presided.

Dr Cama began by pointing out the importance of the application of the techniques of adsorption chromatography and spectroscopy, especially proper calibration of the spectrophotometer, in the investigations on carotenoids and vitamin A. He described and discussed the work that he and his associates had recently carried out on the carotenoids in the red petals of the flowers of Gul-Mohr tree (*Delonix regia*), which contained as many as 25 carotenoids.

He explained the details of the spectrophotometric technique, particularly the use of the three-point correction equations in the assay of vitamin A, along with the results of analysis of Indian marine fish liver oils. Attention was drawn to the importance of the application of appropriate conversion factors for extinction readings at specific wavelengths, by which the original potency of an oxidized oil could be ascertained, and to the possible check on label claims for vitamin A. Spectrophotometric analysis of Indian freshwater fish liver oils, showing the highest amounts of vitamin A_2 hitherto reported in the literature, natural occurrence of anhydrovitamin A_2 and rehydrovitamin A_2 in the fish liver oils, their structural characteristics and absorption spectra were considered.

Dr Cama then discussed the role of vitamins A_1 and A_2 in the visual cycle, and gave an account of the facile preparations of retinene$_2$ and indicator-yellow$_2$ analogues recently made at Bangalore and of their importance in the porphyropsin cycle. Finally he emphasized the importance of vitamin A in the nutrition of the Indian population, in farm animals and in cases of various clinical syndromes.

Dr S. C. Pillai proposed the vote of thanks.

News and Notes

MEETINGS AND EXHIBITIONS

Chemical Society Anniversary Meetings.—The scientific proceedings at the Anniversary Meetings of the Chemical Society, to be held in Liverpool from 11 to 14 April, 1961, will be divided into two sections meeting simultaneously—'Developments in the Chemistry of Boron Compounds' and 'Some Aspects of the Chemistry of Natural Products.' There will be three sessions of lectures and papers in each section. The final programme and application forms will be distributed in December. Further information may be obtained from the Chemical Society, Burlington House, London, W.1.

Corrosion and Metal Finishing Exhibition.—The Corrosion and Metal Finishing Exhibition, organized by *Corrosion Technology*, will be held in the Empire Hall, Olympia, London, from 29 November to 2 December. It is to be opened by Sir Alexander Fleck, K.B.E., F.R.S. At least twice the size of the first exhibition held in 1957, it will also feature technical meetings and films dealing with various aspects of corrosion and metal finishing.

Effluent and Water Treatment Convention.—The First Effluent and Water Treatment Convention, to be held simultaneously with the First Effluent and Water Treatment Exhibition, will take place at the Seymour Hall, London, W.1, on 18–21 October. Papers will cover various methods of controlling and treating different trade wastes, and also deal with river and coastal pollution, pumping, plant design, water softening, and marine water treatment. There is a registration fee of three guineas. Further details may be obtained from Thunderbird Enterprises Ltd, 140 Cromwell Road, London, S.W.7.

OCCA Biennial Conference 1961.—The next Association Conference will take place at Torquay, Devon, from 30 May to 3 June, 1961. The Conference will assemble on the evening of 30 May, and the nine papers, under the general title of 'Physics in Surface Coatings,' will be delivered in three morning sessions on 1–3 June. Non-members wishing to attend are asked to send their names, before 1 December, to the General Secretary, Mr R. H. Hamblin, Wax Chandlers' Hall, Gresham Street, London, E.C.2, from whom further details may be obtained.

Optical Instruments and Techniques.—A conference on Optical Instruments and Techniques is being arranged by the British National Committee for Physics, under the auspices of the International Commission for Optics. It will be held in London from 10 to 14 July, 1961. Enquiries should be addressed to Mr K. J. Habell, National Physical Laboratory, Teddington, Middlesex.

Powders in Industry.—The Surface Activity Group of the Society of Chemical Industry has arranged a symposium entitled 'Powders in Industry: Properties and Principles of Application' to be held at the Royal Institution, 21 Albemarle Street, London, W.1, on 29–30 September. The registration fee is £4. Further information may be obtained from the Hon. Secretary of the Surface Activity Group, 14 Belgrave Square, London, S.W.1.

Pure Food Centenary.—The centenary of the 'Act for Preventing the Adulteration of Articles of Food and Drink' is being commemorated on 20–23 September by a Conference sponsored by four H.M. Ministries and four scientific organizations, among them the Royal Institute of Chemistry. Besides the impressive programme of papers which will be read at the Royal Institution, a series of visits to food factories and control and research laboratories has been arranged for 22 September, and there will be a public Exhibition, including a modern food laboratory and one of 1860, at Charing Cross Underground Station for three weeks. For further details see *J.* 303.

Symposia on Analytical Chemistry.—The second and third symposia in this series, held at the Department of Chemistry, University College of Rhodesia and Nyasaland, took place recently. On 29 July, Mr A. J. Eve introduced the subject 'Polarographic Analysis, with particular reference to the K.1000 Polarograph.' 'Vitamin Assay of Foodstuffs' was the topic of the meeting on 26 August, introduced by Mr W. R. Carr.

The title of the October meeting is 'Complexometric Titration of Metals with EDTA and the New Metal Indicators.' This symposium will be introduced by Mr W. C. Johnson on 21 October.

Scientific Film Association.—The eighth Annual General Meeting of the Scientific Film Association was held on 12 July in the Mullard Theatre, Mullard House, Torrington Place, London, W.C.1. The Honorary Officers elected for 1960–61 were: President, Mr Edgar Anstey; Vice-President, Dr Michael Essex-Lopresti; Honorary Treasurer, Dr J. H. Pryor, *Fellow.*

The Annual Meeting was preceded by a showing of films, including a preview of the latest film sponsored by Mullard Ltd entitled 'Invisible Force.'

Scientific Film Review, the journal of the Scientific Film Association, and *Science and Film*, the journal of the International Scientific Film Association, have been amalgamated. It was felt that there was a considerable overlap between the two journals, and so the Scientific Film Association has agreed to publish a new journal, *Scientific Film*, on behalf of the International Scientific Film Association, incorporating the essential features of both the former journals. *Scientific Film* appears bimonthly, and contains articles in both English and French. The first issue was published in June.

IRRADIATION OF PHARMACEUTICALS

Sterilization of pharmaceutical products, particularly those of a thermo-labile nature, presents many problems for which no really satisfactory solution is yet available. The possibility of sterilization by irradiation is an attractive one, and would be of immense interest to the industry provided that it could be done:—

(*a*) effectively;

(*b*) without deleterious effect on products or containers;

(*c*) at reasonable cost.

A report on *The Use of Gamma Radiation Sources for the Sterilisation of Pharmaceutical Products*, published by the Association of British Pharmaceutical Industry, summarizes work done during the past four years in the laboratories of a number of well-known firms in the industry, with the collaboration of the School of Pharmacy of the University of London and the Isotope Division of the A.E.R.E.

It is shown that an irradiation dose of $2{\cdot}5 \times 10^6$ rad is normally the minimum required to ensure sterilization, but unfortunately an unacceptable degree of deterioration of the product nearly always occurs at that dosage.

Figures given regarding cost indicate a capital investment of the order of £100,000 and an operating cost of $3\frac{1}{2}d.$ per lb, but it is pointed out that this low unit cost might be very greatly exceeded in actual practice, especially on relatively short runs. Hence, even if the technical difficulties could be overcome, some difficult economic problems would remain.

The hope is expressed that individual members will 'follow up such aspects of these investigations as appear to be of particular interest or significance', but it is concluded that there is no justification for continuation of the work on a collaborative basis.

There is no indication as to the cost of the investigation or how it was financed, but it must have involved substantial expenditure. One wonders if progress is likely to be made in the absence of further collaboration, perhaps on an even wider scale involving industries (such as food processing) outside the pharmaceutical field.

The Council of the Association of British Pharmaceutical Industry is to be congratulated on initiating this work, but it is to be hoped that it will not allow the matter to drop at this inconclusive stage.

R. H. HENRIKSEN

Society of Dyers and Colourists.—Dr Maurice Tordoff has been appointed Editor and Technical Officer of the Society, and took up his duties on 1 August.

Approved Names.—The General Medical Council has published a list of Approved Names dated June, 1960, giving all Approved Names issued since 1948, together with Approved Names issued earlier for substances which have not become the subject of official monographs. The list is available from the Secretary, British Pharmacopoeia Commission, 44 Hallam Street, London, W.1., as is a supplementary list dated August, 1960.

Fertilisers and Feeding Stuffs Act, 1926.—New regulations under the above Act, entitled 'The Fertilisers and Feeding Stuffs Regulations, 1960' (S.I. 1960, No. 1165) have now been made by the Minister of Agriculture, Fisheries and Food and the Secretary of State for Scotland. They come into operation on 1 October, and replace the current Regulations made in 1955 and 1956. Copies may be obtained from H.M.S.O. or through any bookseller, price 2*s*. 6*d*. net.

Humphrey Raikes Building.—The official opening of the new chemistry block of the University of the Witwatersrand, Johannesburg, took place on 29 June. The building is named after the late Dr Humphrey R. Raikes, a distinguished chemist and principal of the University for 26 years. The steady expansion of the activities of the chemistry department, particularly the increase in student numbers in recent years, rendered the previous accommodation inadequate, and the University Council therefore decided to proceed with the construction of a new building at a cost of more than £300,000. The new building has what is believed to be the largest chemistry laboratory in South Africa.

After an address of welcome by the Chairman of the Council, Mr B. L. Bernstein, the Building was formally opened by Mr H. F. Oppenheimer. Having inspected the Building, visitors took refreshments in the Wilkinson Laboratory.

The Institute of Physics.—The report of the Institute of Physics for 1959, which was adopted at the final meeting of the Institute before its amalgamation with the Physical Society, shows that at the end of the year the total membership in all grades was 6,754, an increase of 445 on the previous year. The number of applications for membership continued to increase, and reached a new record of 933 during the year. The report records that at a General Meeting on 1 December the scheme of amalgamation was unanimously adopted, and the Board was requested to take the necessary action to implement the proposals.

The number of candidates entering for the Graduateship examination of the Institute continued to increase at a very satisfactory rate; 119 candidates took papers compared with 80 the previous year. Only 39 candidates were successful and of these 13 held university degrees and 26 the Higher National Certificate in applied physics.

The report again records expanding activities in education, scientific publications and meetings.

Obituary

Francis William Frederick Arnaud. *B*. 7.1.1879. *Ed*. King's College, London, 1899–1901. He became a pupil of Mr C. H. Cribb, Public Analyst to the City of Westminster, in 1897, and continued as his assistant until 1906, when he was appointed Borough Analyst for Portsmouth. In 1913 he was appointed Public Analyst and Official Agricultural Analyst for the County of Kent, a position which he held until his retirement in 1946. Thereafter he acted for a time in an advisory capacity to the Hernden group of farms. In his early life he was a fine athlete. He was a prominent Freemason, and his chief hobby was gardening, though he had many and varied interests. 'A man of utter integrity, abstemious, respected by all, his friends were legion.' (*A*. 1902, *F*. 1905; Council 1911–14, 1925–28.) *D*. 15.3.60.

Edgar Arundel. *B*. 1895. *Ed*. University College, London, 1912–15. B.Sc. His first appointment was to the Bristol Photographic Research Association. He left in 1919 to join F. Claudet Ltd, and in 1923 became a research chemist to Cafferata & Co. Ltd. Some years later he was appointed a research chemist to British Plaster Board Ltd, a post which he retained until his retirement in 1959. (*A*. 1915, *F*. 1922.) *D*. 28.3.60.

Ernest Edward Ayling. *B*. 27.8.1900. *Ed*. Ashford Secondary School, Middlesex; King's College, London, 1917–20. B.Sc., A.K.C. He was a demonstrator in chemistry at King's College for a few months until the end of 1920, when he was appointed assistant lecturer in chemistry at University College, Swansea, where he remained for the rest of his life. He was awarded the degree of M.Sc. (Lond.) in 1926, appointed a lecturer in 1930, a senior lecturer in 1958 and was acting head of the department of chemistry for part of the session 1956–57. He was one of a small band of pioneers who established the University College of Swansea. He gave forty years of devoted service to the College and to the profession of chemistry, in particular to the Institute. He applied himself vigorously to researches in organic chemistry and he was the author or co-author of numerous scientific papers, but he will be remembered more for his outstanding talents as a teacher, which he so ably developed during a difficult period in the advancement of a new University College. His knowledge of the students whom he had taught was remarkable and his ability to recall details of their careers was always a source of amazement to his colleagues. He served the Institute of Civil Defence as Chairman of the South Wales Group and as a member of the Welsh Branch Council, and, at the time of his very sudden death, had been Hon. Secretary of the South Wales Section of the Institute for very nearly 21 years. In all

these activities he endeared himself to a wide circle of friends by his modesty, sincerity and sympathetic interest for the many who sought his advice. The chemistry department at Swansea will always remain conscious of the debt it owes to his untiring work and devotion to duty, and it is very fitting that his memory is to be perpetuated in the department by 'The Ayling Prize' which is being established for students in their final Honours year. (*A.* 1921, *F.* 1931; Council 1941–44.) *D.* 30.3.60.

Peter Richie Buchanan. *B.* 16.10.1900. *Ed.* Ardrossan Academy; Royal Technical College, Glasgow, 1920–24. B.Sc. He became an apprentice chemist at Nobel's Explosives Co. Ltd in 1917, and served in the Royal Air Force, 1918–19. On completion of his studies, he joined the Anglo-Scottish Beet Corporation as an assistant chemist in 1925, becoming works chemist the following year. He left in 1936 on his appointment as chief chemist to the British Sugar Corporation Ltd, where he remained until the time of his death, when he was assistant works manager. (*A.* 1925.) *D.* 31.5.60.

Arthur Sidney Carlos. *B.* 5.1.1888. *Ed.* Birkbeck College, London, 1905–14. B.Sc. He became an assistant analyst with Muter and Hackman in 1909. Thereafter he was successively assistant chemist, inspection department, Royal Arsenal, Woolwich, 1915, research chemist and assistant manager, Abbey Chemical Co., June, 1916 and chemist and superintendent, H.M. Factory, Walthamstow, November, 1916. He set up his own consulting practice in 1920. During the Second World War, he was in charge of the inspection of explosives in the CIA-A I.P.C. division of the Ministry of Supply. After the war he returned to his private practice in Bournemouth which he started to rebuild. In 1950 he was appointed Public Analyst for the Borough of Poole, and in 1953 Public Analyst for the County Borough of Bournemouth. Later he became consultant chemist for the new Christchurch Sewage Disposal Works. He was also the analyst for the Avon and Dorset River Board, and carried out the water analysis for the proposed atomic power station at Winfrith Heath, Dorset. He was a Rotarian and Freemason, but his main interest was in the Scout Movement, of which he was District Commissioner for the Christchurch Area for 10 years, having been Assistant District Commissioner for 16 years previously. 'He was absolutely incorruptible and worked with no thought of gain for himself.' (*A.* 1915, *F.* 1918.) *D.* 17.6.60.

Leslie Kenneth Hall. *B.* 30.5.12. *Ed.* Municipal Technical College, Blackburn, 1928–34. He entered the research department of the L.M. & S. Railway as an assistant chemist in 1932, becoming analytical and research chemist in 1934. He remained with the research department when it was taken over by British Railways, and at the time of his death was senior technical assistant. (*A.* 1951.) *D.* 13.3.60.

Ernest Mostyn Hawkins. *B.* 5.3.1875. *Ed.* Finsbury Technical College, 1889–92. His first post was as chemist to the Frederick Crane Chemical Co. in 1894. The following year he joined Grimble & Co. Ltd as chemist and brewer, where he remained until 1900, when he became assistant to Mr Sidney Harvey, Public Analyst. He succeeded Mr Harvey as Public Analyst in 1915 and took over the consulting practice, where he remained until his retirement in 1951. For many years he served on the Benevolent Fund Committee of the Institute and maintained a lively interest in the work of the Committee long after his retirement. (*A.* 1897, *F.* 1900; Council 1917–20, 1924–27; Vice-President 1920–23, 1927–30.) *D.* 7.12.59.

Samuel Percy Hughes. *B.* 17.3.1894. *Ed.* North Wales Training College for Teachers; University College of North Wales, 1920–24. M.Sc. He served with H.M. Forces, 1914–18, before returning to his studies. He was appointed senior science master at the Central School, Lichfield, in 1924, and five years later took a similar post at Deeside Central School, Shotton. He became headmaster of Flint County Secondary School in 1935, a position which he held until his retirement in 1959. He played a leading part in the development of secondary modern and technical education in Flintshire. For many and varied services to education in Flintshire and North Wales he was appointed O.B.E. in 1954. 'He gave unsparingly of his talents and time to his fellow beings and was admired for his sincerity and integrity, his friendly and genial manner.' (*A.* 1926.) *D.* 11.5.60.

Leslie Gordon Lawrie. *B.* 15.4.1891. *Ed.* Manchester Grammar School; Manchester College of Technology, 1907–10. He took a post as chemist to James Templeton & Co., Glasgow, in 1910. He went to Germany in 1914 as a chemist to the Badische Co. but returned six months later and served in H.M. Forces, 1915–19. He joined the British Dyestuffs Corporation (now Imperial Chemical Industries Ltd) in 1919 as a research chemist, and remained there until his retirement. He was the author of *A Bibliography of Dyeing* (1949). (*A.* 1921.) *D.* 4.6.59.

John Alexander Lloyd. *B.* 31.5.1878. *Ed.* Mason College, Birmingham (now the University), 1896–1901; University of Würzburg, 1901–03. B.Sc. (Lond.), M.Sc. (Birm.), Ph.D. (Würzburg). He became a research chemist at Badische Anilin-und Soda-Fabrik, Ludwigshafen, Germany, in 1903, and later took a post in the patent department. He was interned in Germany during the First World War, and for a short time after his return to England was a chemist with Brotherton & Co. Ltd. He joined Courtaulds Ltd in 1920, and after a short period at one of the mills was

given the task of setting up a patents department, of which he remained head until his retirement in 1947. He was retained for a further three years in the capacity of consultant. During the time he spent in Germany, his chief interests were mountaineering and tennis. On his return to this country, his main hobby was gardening and after his retirement he became an enthusiastic non-playing member of Warwickshire County Cricket Club. He was closely associated with Coventry Cathedral, and was a churchwarden, 1935–40. (*A.* 1901, *F.* 1905.) *D.* 3.4.60.

David Archibald Whyte Macpherson. *B.* 22.11.10. *Ed.* Dundee High School; Dundee Technical College, 1932–35, 1938–39; University College (now Queen's College) Dundee, 1933–35, 1938–39; Rutherford College, Newcastle-upon-Tyne, 1937–38. He served as chief laboratory assistant at Martin & Martin Ltd, Newcastle, 1935–38, before returning to his studies in Dundee. He joined the research department, Imperial Chemical Industries Ltd, Dyestuffs Division, Blackley, in 1940, was transferred to the experimental department of Dalton Works, Huddersfield, in 1943, and was again transferred in 1948 to the naphthalene department of the same works. He was appointed head of the resins department in 1951. He returned to the naphthalene department in the same capacity in 1955, and his extensive knowledge of naphthalene chemistry and wholehearted enthusiasm were an inspiration to all who worked with him. In his early days he was a fine hockey player. Later his main hobby was gardening, with fishing on some quiet Scottish river as an annual holiday relaxation. He was an active Christian worker in St James' Presbyterian Church, Huddersfield, where he served as an elder for 15 years. (*A.* 1940.) *D.* 19.5.60.

John McCrae. *B.* 31.7.1875. *Ed.* Glasgow and West of Scotland Technical College, 1891–93; University of Heidelberg, 1893–95. Ph.D. (Heidelberg). He became an instructor in chemistry at the University of Cincinnati in 1895 and thereafter was successively Priestley scholar at the Mason College, Birmingham (now the University), 1896, demonstrator and assistant lecturer at the Yorkshire College, Leeds (now the University), 1897 and lecturer at East London Technical College (now Queen Mary College), 1902. He was appointed lecturer in chemistry at Queen Margaret College (the women's department of the University of Glasgow) in 1902, but relinquished the post without having taken up his duties to accept an appointment as chief assistant chemist to the Transvaal Department of Agriculture, becoming acting chief chemist in 1905. He was appointed Government Analyst for the Transvaal in 1906, a post which he held until his retirement in 1930. Thereafter he was for a time consulting chemist to the Rand Water Board. For many years he acted as Honorary Corresponding Secretary for the Transvaal on behalf of the Institute. (*F.* 1906.) *D.* 12.4.60.

Robert Geoffrey Oehlcke. *B.* 15.8.31. *Ed.* Stockport School; Stockport College, 1950–55. He became a research assistant in the rayon research laboratory of the British Cotton Industry Research Association in 1950. Subsequently he took similar posts in the research laboratory of Simon–Carves Ltd in 1952 and in the biochemical laboratory of the Christie Hospital, Manchester, in 1956. He left two years later on his appointment as technical representative at Hoechst Chemicals Ltd, Manchester, a post which he held until his untimely death. (*A.* 1959.) *D.* 25.3.60.

Lionel Hewgill Smith. *B.* 11.7.1891. *Ed.* Bridlington Grammar School; Hull Technical College. He was appointed assistant chemist to J. B. Walker & Co. Ltd, Hull, in 1908. He joined the New Transvaal Chemical Co. Ltd as a chemist in 1911, and took a similar post first at the Gravesend Oil Works in 1914, and four years later at the British Extracting Co. Ltd, a subsidiary of the British Oil & Cake Mills Ltd. He later became chief chemist for the Hull area, a position which he held until his retirement in 1956. Thereafter he acted in an advisory capacity to Couper, Friend & Co. Ltd, of Hull and London. (*A.* 1927, *F.* 1930.) *D.* 27.3.60.

George Ernest Willis. *B.* 7.10.12. *Ed.* Westoe Secondary School, South Shields; King's College, Newcastle upon Tyne, 1931–34. B.Sc. (Dunelm.), Ph.D., 1939. He continued at King's College as a research student and demonstrator until 1937, when he became a research chemist at Priestman Collieries Ltd. The following year he took a similar post at Imperial Chemical Industries Ltd, Dyestuffs Division, where he remained for the rest of his life. (*A.* 1939.) *D.* 1.5.60.

THE REGISTER

DEATHS

Fellows

(N) BEARDER, Ernest Arthur, M.B.E., M.SC. (LEEDS). Died 22 July, 1960, aged 73. *A.* 1918, *F.* 1924.

(EE) DAVEY, Henry Gethin, O.B.E., M.SC. (WALES). Died 7 August, 1960, aged 51. *A.* 1932, *F.* 1944.

(P) FARMER, Robert Crosbie, O.B.E., M.SC. (BIRM.), PH.D. (WÜRZBURG), D.SC. (LIV.). Died 30 July, 1960, aged 82. *F.* 1916.

(C) LOCKWOOD, Harold Claude, B.SC., PH.D. (LOND.). Died 14 August, 1960, aged 58. *A.* 1928, *F.* 1935.

(O) LOWE, Harold, M.SC. (MANC.). Died 23 July, 1960, aged 72. *A.* 1911, *F.* 1914.

(K) PICTON, Norman, B.SC. (WALES), PH.D. (LEIPZIG). Died 28 July, 1960, aged 75. *F.* 1917.

(P) WALLIS, Albert Edward. Died 12 August, 1960, aged 68. *F.* 1932.

Associate

(S) MARSDEN, William. Died August, 1960, aged 57. *A.* 1942.

Erratum.—The degrees of Denis BENSON (*See J.*, 308) should have read B.SC., PH.D. (LIV.).

LOCAL SECTIONS OF THE INSTITUTE

DIARY OF MEETINGS

☞ Sections are glad to welcome members of other Sections to their meetings and social functions, except when numbers are restricted, as for works visits. Those wishing to attend meetings outside their own area are advised to write to the Hon. Secretary of the Section concerned, as the Institute cannot accept responsibility for any alterations or cancellations. All times are p.m. except where otherwise stated.

(A) **Aberdeen.** 14 Oct. 8. Structure of Proteins. Prof. M. F. Perutz. Robert Gordon's Technical College. Joint, C.S. and S.C.I.

(P) **Acton.** 27 Oct. 7. Some Aspects of Ion Exchange Resins. Prof. C. W. Davies. Borough Polytechnic, Borough Road, S.E.1. Joint, Polytechnic Chem. Soc.

(T) **Bangor.** 30 Sept.–1 Oct. Joint Meetings with Society for Analytical Chemistry. Prof. R. Belcher and Prof. C. L. Wilson. University College of North Wales

(B) **Belfast.** 7 Oct. 7.45. The Effects of Synthetic Detergents on the Public Health Services. Dr B. A. Southgate. Queen's University

(SS) **Blackpool.** 29 Sept. 7.15. Inaugural Dinner and Address. Dr M. Pyke. Catering College

(Q) **Bolton.** 13 Oct. 7.15. The Scientific Examination of Paintings and Antiquities. Dr A. E. Werner. Technical College

(P) **Brighton.** 11 Oct. 7. Synthetic Fibres. Dr C. A. Finch. Technical College. Joint, College Chem. Soc.

(P) **Cambridge.** 5 Oct. 7.45. Adhesion and Adhesives. Dr N. A. de Bruyne. Technological Research Station, Spillers Ltd, Station Road

(E) **Cardiff.** 28 Oct. 7. Calculation of Reactor Volume from Laboratory Data. Dr Strickland-Constable. University College. Joint, Inst. Chem. E.

(P) **Chatham.** 25 Oct. 7.30. Some Observations on Analytical Chemistry. Dr J. Haslam. Medway College of Technology, Maidstone Road

(T) **Connah's Quay.** 19 Oct. 7. Fluorine: The Taming of an Element. Dr W. H. Wilson. Flintshire Technical College

(P) **Croydon.** 6 Oct. 6.30. Film Show. Technical College, Fairfield

(P) **Dagenham.** 20 Oct. 7. Some Chemical Aspects of Colour Photography. Dr G. I. P. Levenson. South-East Essex Technical College, Longbridge Road. Joint, College Scientific Soc.

(S) **Durham.** 27 Oct. 8. Natural Raw Materials for the Chemical Industry in the North East. Prof. K. C. Dunham. Applebey Lecture Theatre. Joint, S.C.I.

(J) **Edinburgh.** 20 Oct. 7.30. Science in Art and Archaeology. Dr A. E. Werner. North British Hotel. Joint, C.S. and S.C.I.

(WW) **Falkirk.** 12 Oct. 7.30. International Science. Dr F. N. Woodward. Lea Park Rooms

(K) **Glasgow.** 14 Oct. 7.15. Lecture by a member of Consumers' Association Ltd, publishers of 'Which?' Royal College of Science and Technology

(D) **Gloucester.** 27 Oct. 7.30. Alkyd Resins. Technical College. Joint, Plastics Institute

(L) **Huddersfield.** 20 Sept. 7.30. A discussion of Institute matters with particular reference to Grades of Membership. Dr G. R. Ramage and Dr R. L. Elliott. Alexandra Chambers, John William Street
—— 18 Oct. 7.30. The Safety in use of Chemical Aids in Food Technology. Prof. A. C. Frazer. Alexandra Chambers

(M) **Hull.** 28 Sept. 7.30. Scientific Film Evening. Francis Reckitt Institute, Dansom Lane

(O) **Liverpool.** 6 Oct. 7. Reflections on the Design and Organization of Analytical Laboratories. E. Myer. Donnan Laboratories, The University

(P) **London.** 12 Oct. 7. Humphry Davy Lecture. Energy Exchange in the Interaction of Particles under Electric Discharge. Prof. V. N. Kondratiev. The Royal Institution, Albemarle Street, W.1

(H) **Loughborough.** 13 Oct. 7.30. The Electronic Factors in Catalysis. Prof. D. D. Eley. Schofield Building, Ashby Road. Joint, Loughborough Colleges' Chem. and Chem. Eng. Soc.

(P) **Luton.** 28 Sept. 7.30. Science in the Detection of Crime. Dr I. G. Holden. College of Technology. Joint, Luton Scientific Soc.

(Q) **Manchester.** 30 Sept. 2. Structure in Hypotensive Agents. I.C.I. Ltd. (Pharmaceuticals Division), Alderley Park. Joint, S.C.I.
—— 28 Oct. 7. Dalton Lecture. Chemistry in Everyday Life—The Contribution of D.S.I.R. Sir Harry Melville. Town Hall

(P) **New Cross.** 26 Oct. 7. Modern Colour Photographic Processes. R. B. Collins. Goldsmiths' College, Lewisham Way, S.E.14. Public Lecture

(E) **Newport.** 23 Sept. 7. Modern Paint Technology. F. J. Long. College of Technology. Joint, S.C.I.

(X) **Norton.** 22 Sept. 8. Annual General Meeting, William Newton School.
—— 28 Oct. 8. Mechanism of Epoxide Reactions. Dr R. E. Parker. William Newton School

(W) **Plymouth.** 14 Oct. 5.30. Radio-Chemistry. A. B. Heslop. Technical College

(R) **Portsmouth.** 24 Oct. 7. Bacterial Corrosion. Dr G. H. Booth. College of Technology. Joint, C.S.

(R) **Salisbury.** 21 Oct. 7.45. Some Observations on Analytical Chemistry. Dr J. Haslam. Red Lion Hotel. Joint, S.A.C.

(C) **Solihull.** 23 Sept. 8. Dinner and Dance. George Hotel

(R) **Southampton.** 14 Oct. 4.30. Chemical Binding and Molecular Architecture. Prof. R. S. Nyholm. Taunton's School. Joint, Science Masters' Assoc.

(C) **Stoke-on-Trent.** 27 Oct. 7.30. Colour and Colour Measurement. G. J. Chamberlin. North Staffordshire Technical College

(D) **Street.** 13 Oct. 6.30. Vegetable Tannins. Dr T. White. C. & J. Clark Ltd

(S) **Sunderland.** 20 Oct. 6.30. Some aspects of Research on Plant Growth Substances. Prof. R. L. Wain. Technical College

(SS) **Ulverston.** 21 Oct. 6.30. Infra-Red Spectroscopy. Dr L. J. Bellamy. Sun Hotel. Joint, Glaxo Scientific Soc.

HON. SECRETARIES

Section	*Hon. Secretary*
(A) Aberdeen and North of Scotland	**P. N. Hobson,** B.SC., PH.D., F.R.I.C., Rowett Research Institute, Bucksburn, Aberdeen
(B) Belfast and District	**R. J. Magee,** M.SC., PH.D., F.R.I.C., 255, Holywood Road, Belfast
(C) Birmingham and Midlands	**J. E. Gregory,** B.SC., PH.D., F.R.I.C., 5, Silvermead Road, Sutton Coldfield
(D) Bristol and District	**R. W. Bolland,** B.SC., PH.D., F.R.I.C., College of Technology, Ashley Down, Bristol, 7
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(F) Dublin and District	**J. T. O'Herlihy,** B.SC., F.R.I.C., 21, Ballymun Avenue, Ballymun, Dublin
(FF) Dundee and District	**K. R. Hargreaves,** B.SC., PH.D., F.R.I.C., Chemistry Department, The Technical College, Bell Street, Dundee
(G) East Anglia	**H. F. Bamford,** M.A., F.R.I.C., John Mackintosh & Sons, Ltd (Caley Branch), Chapelfield Works, Norwich
(H) East Midlands	**R. W. Hale,** B.SC., F.R.I.C., Blakeney, Tollerton Lane, Tollerton, Nottingham
(J) Edinburgh and East of Scotland	**K. A. Scott,** A.R.I.C., Department of Pharmacology, University New Buildings, Teviot Place, Edinburgh, 8
(K) Glasgow and West of Scotland	**W. Gibb,** B.SC., PH.D., A.R.T.C., A.M.INST.F., A.R.I.C., Department of Technical Chemistry, Royal College of Science and Technology, George Street, Glasgow, C.1
(L) Huddersfield	**F. W. Jarvis,** B.SC., F.R.I.C., 577, Bradford Road, Bradley Bar, Huddersfield
(M) Hull and District	**L. Malin,** B.SC., A.R.I.C., The Universal Oil Co. Ltd, Oak Road, Newland, Hull
(N) Leeds Area	**W. A. Wightman,** M.A., F.R.I.C., The University, Leeds, 2
(O) Liverpool and North-Western	**H. R. Jones,** B.SC., F.R.I.C., The Central College of Further Education, Carlett Park, Eastham, Wirral
(P) London	**G. C. Ackroyd,** B.SC., A.R.I.C., Second Floor, 107, Cheapside, London, E.C.2
(Q) Manchester and District	**R. Shackleton,** F.R.I.C., Magnesium Elektron Ltd, P.O. Box No. 6, Clifton Junction, Manchester
(R) Mid-Southern Counties	**T. F. McCombie,** A.R.I.C., 50, Springdale Avenue, Broadstone, Dorset
(S) Newcastle upon Tyne and North-East Coast	**H. L. Hutton,** B.SC., F.R.I.C., 26, Long Close Road, Hamsterley Mill Estate, Rowlands Gill, Co. Durham
(SS) North Lancashire	**R. E. Wilson,** B.SC., A.R.I.C., 315, Blackpool Road, Preston, Lancs.
(T) North Wales	**S. McLintock,** B.SC., F.R.I.C., Chemistry and Metallurgy Dept, Flintshire Technical College, Connah's Quay, Nr Chester
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(W) South-Western Counties	**B. M. Dougall,** M.SC.AGRIC., F.G.S., A.R.I.C., Chemistry Dept, Seale-Hayne Agricultural College, Newton Abbot, Devon
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(X) Tees-side	**G. H. Mansfield,** B.SC., PH.D., A.R.I.C., 86, Harlsey Road, Hartburn, Stockton-on-Tees, Co. Durham
(Y) Thames Valley	**E. S. Lane,** B.SC., PH.D., F.R.I.C., Building 429, Chemistry Division, A.E.R.E., Harwell
(OA) Malaya	**W. Rintoul,** B.SC., PH.D., F.R.I.C., 200A, New Race Course, Bukit Timah, Singapore, 11
(OB) Cape	**J. F. Largier,** M.SC., PH.D., A.R.I.C., Little Acorn, Bishopsgate Drive, Claremont, Cape Town
(OC) New Zealand	**H. J. Wood,** B.SC., F.R.I.C., Dominion Laboratory, Sydney Street West, Wellington
(OD) Deccan	**S. C. Pillai,** B.A., PH.D., A.I.I.SC., M.INST.S.P., A.R.I.C., Indian Institute of Science, Bangalore, 12, India
(OE) Madras	**K. R. Srinivasan,** M.A., F.R.I.C., King Institute, Guindy, Madras, 15, S. India
(OF) Western India	**J. R. Merchant,** M.SC., PH.D., A.R.I.C., Institute of Science, Mayo Road, Bombay, 1, India
(OG) Northern India	**S. K. Mukerjee,** M.SC., PH.D., A.R.I.C., Department of Chemistry, The University, Delhi, 8, India
(OH) Eastern India	**A. B. Sen Gupta,** M.SC., PH.D., F.T.I., F.R.I.C., Indian Jute Mills Association Research Institute, 17, Taratola Road, Calcutta, 27
(OJ) Ceylon	**C. Sathunanthan,** B.SC., S.M., F.R.I.C., Department of Government Analyst, Torrington Square, Colombo, 7, Ceylon
(OK) East Africa	**R. F. Naylor,** B.SC., PH.D., A.R.C.S., D.I.C., F.R.I.C., Department of Chemistry, Makerere College, P.O. Box 262, Kampala, Uganda